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SYNOPTIC ANALYSES, 5-, 2-, AND 0.4-MILLIBAR SURFACES FOR JULY 1973 THROUGH JUNE 1974

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
and
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Staff, Upper Air Branch

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SYNOPTIC ANALYSES, 5-, 2-, AND 0.4-MILLIBAR SURFACES FOR JULY 1973 THROUGH JUNE 1974

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NOAA, National Weather Service, National Meteorological Center

SUMMARY

Satellite radiance measurements and data from meteorological rocketsondes have been employed to analyze a series of high-altitude constant-pressure charts. The methods of processing the various types of data and the analysis procedure used are described.

Broad-scale analyses for the Northern Hemisphere 5-, 2-, and 0.4-mb surfaces are presented for each week of the period from September through April, and on a once-per-month basis for July, August, May, and June.

A brief discussion of the variations of the temperature and height fields throughout the year is also given.

INTRODUCTION

This report is the seventh in a series of constant-pressure charts for the upper stratosphere and lower mesosphere. Previously, charts for 1964-68 (refs. 1, 2, 3, 4, and 5) were analyzed at weekly intervals and were based on meteorological rocketsonde and very high-level rawinsonde data obtained throughout North America and adjacent ocean areas (refs. 6 and 7). Since 1972 it has been possible to extend the analyses to most of the Northern Hemisphere (refs. 8 and 9). Figure 11 shows the locations of the

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[1]Personnel actively engaged in this report were: Manager, F. G. Finger; Coordinator and Analyst, M. E. Gelman; Analyst, R. M. Nagatani; Research Consultants, R. S. Quiroz, A. J. Miller, and J. D. Laver; and data processing, D. L. Griffith.

20 meteorological rocket launch sites for which data were available. Because of improvements in the methods of routine transmission and receipt of rocketsonde data by the teletypewriter-coded ROCOB messages, charts could be constructed from these data with considerably less delay than was previously entailed by use of the checked rocketsonde data in published form (ref. 7).

In addition, since 1972 data from satellite vertical temperature sounding instruments have become available (see section on satellite data, below). When used together with the expanded number of in situ observations, these provide for greatly improved data coverage over the entire hemisphere.

This present series of analyses of the 5-, 2-, and 0.4-mb surfaces (approximately 36, 42, and 55 km, respectively) portrays the broad-scale synoptic conditions over the Northern Hemisphere on Wednesdays during July 1973 through June 1974. Charts are presented weekly during the meteorologically active winter months and transition periods, and monthly during the summer months. The reduced frequency appears sufficient to depict the slow, broad-scale changes that occur in summer. Small-scale time and space changes and planetary waves of small amplitude (ref. 10) are observed during summer, but the horizontal resolution of the analyses in most areas are not sufficient to depict them. During winter and the transition periods, large changes may be evident from one week to the next. Sometimes, these variations occur within a day or two and may be inferred from the sequence of up to three observations plotted at each rocket station. Thus, the user may enhance the utility of the weekly charts by noting any large changes during the week in plotted temperature or wind direction, and inferring movement of the synoptic systems depicted in the Wednesday charts.

Despite the omission of the smaller-scale details, the maps are very useful for a number of applications. Examples include determining the trajectory of constant-level balloons, relating variations in infrasound propagation to circulation changes, and providing a data base (climatological and synoptic) for evaluating environmental effects on aerospace vehicles. In addition, users have pointed to the increasing utility of these maps for studies of stratospheric-ionospheric interaction, for verification of the performance of numerical circulation models, and for various other research efforts.

PROCESSING OF ROCKETSONDE DATA

Temperature, height, and wind information derived from routine meteorological rocketsonde observations comprised the basic

data for analyses at the 5-, 2-, and 0.4-mb levels. Rocketsonde information used for this project were obtained from teletype coded ROCOB messages (WMO code FM39.E ROCOB and FM40.E ROCOB ship). These data were usually transmitted from each rocketsonde station within one day of observation. Data from Heiss Island, Volgograd, and Thumba were available in ROCOB format within one week of observation time.

The ROCOB message generally provides data in the form of temperature and wind versus geometric height. In these cases, the vertical coordinate must be transformed from height to pressure so that temperature, height, and wind information may be extracted at the desired pressure levels.

A variety of problems may restrict the accuracy of measured temperatures at the higher rocketsonde levels. Thus, in most cases correction systems have been derived by theoretical or laboratory methods. For the U.S. Datasonde System, the most recent temperature correction scheme (ref. 11) considers aerodynamic heating (which depends mainly on the fall velocity of the sensor), thermal lag, emitted and absorbed radiation, and electrical heating. Precise corrections based on these factors have generally been applied to published U.S. data since January 1973. However, corrections were not applied to the U.S. data sent in ROCOB messages until after the period of the maps under discussion here. Typical values of temperature correction at various heights of the 0.4-mb surface (based on average sensor fall velocity) are listed in Table 1c (for daylight and for darkness).

TABLE 1. - THEORETICAL CORRECTIONS AND EMPIRICAL TEMPERATURE ADJUSTMENTS (°C) DERIVED TO OBTAIN COMPATIBILITY BETWEEN U.S. AND U.S.S.R. ROCKETSONDE MEASUREMENTS

	(a)		(b)	(c)	
KM	U.S. ADJUSTMENT		U.S.S.R. ADJUSTMENT	AVERAGE THEORETICAL U.S. CORRECTION	
	DAY	NIGHT		DAY	NIGHT
58	-16	-4	+9	-6.0	-3.6
55	-8	-2	+7	-4.2	-2.4
50	-5	-1	+2	-2.5	-1.4

International (WMO sponsored) rocketsonde intercomparisons have shown (ref. 12) that there are large differences between temperatures reported from U.S. and U.S.S.R. soundings, even after each set of data has been "corrected" according to latest theoretical and laboratory results. For this reason an adjustment to (uncorrected) temperatures reported in ROCOB messages has been applied to U.S. data (Table 1a) and to U.S.S.R. data (Table 1b). These adjustments are somewhat different from those recommended in ref. 12, but were adopted to insure consistency with adjustments applied to previous analyses.

The partially computerized procedure for calculating pressure and extracting the required information for the 5-, 2-, and 0.4-mb levels was as follows:

a. Pressure was calculated at each ROCOB reported level by integrating the hydrostatic equation starting at a base level near 50 mb. Temperature and height data obtained from a nearby rawinsonde station were used as the reference-level data. The geopotential heights and temperatures at the 5-, 2-, and 0.4-mb levels were then interpolated.

b. Wind direction and wind speed were interpolated manually at the calculated height of each analysis level. When temperature data were not available for a particular sounding, the wind information was extracted at individually estimated heights of the 5-, 2-, and 0.4-mb levels.

c. Time-height diagrams were plotted for each rocketsonde station. The temperature and wind information on these diagrams provided valuable verification of the sequence of meteorological changes. Erroneous or questionable data could be quickly isolated in this manner.

d. From the wind information plotted on the time-height diagrams, thermal winds were determined for approximately 6-km layers surrounding each analysis level. Although there were rapid wind oscillations with height at times, usually an unambiguous direction for the thermal wind could be determined.

PLOTTING OF DATA

The rocketsonde data - temperature (C°), height (geopotential meters), wind direction and speed (knots) - were plotted on a polar stereographic map base. On the charts presented for publication, three available observations closest to Wednesday are shown for each station. Reported heights and calculated thermal winds have been omitted for the sake of legibility. The station

model chart (Fig. 11) illustrates the symbols used to distinguish data obtained on Wednesdays from off-time data.

USE OF SATELLITE DATA

Nimbus 5 Selective Chopper Radiometer (SCR) (ref. 13) and NOAA 2 and 3 Vertical Temperature Profile Radiometer (VTPR) (ref. 14) were used for the 1973-74 analyses. The method of using the remotely sensed temperature information for determining stratospheric thickness is given in ref. 15. In brief, the radiant energy sensed by a satellite instrument in any spectral band is representative of the weighted temperature from a substantial layer in the atmosphere. Single-channel relationships were derived relating satellite measured radiances and the radiosonde-rocketsonde thickness (or mean temperature) between the 100- to 5-mb, 100- to 2-mb, and 10- to 0.4-mb levels. These thickness relationships are shown in Fig. 1a. A table was then constructed relating observed radiance with thickness values at 320-meter intervals for each of these atmospheric layers.

The relationships between satellite-measured radiances and radiosonde-rocketsonde height thicknesses were used as an aid in constructing the analyses in the following manner:

a. Radiance-map fields containing 24 hours of satellite data were analyzed (Fig. 2).

b. Radiance isopleths were converted to thickness isopleths by the use of the radiance-thickness relationships (Fig. 1a).

c. The thickness field was then added to the analyzed height field of a base chart; either an objectively analyzed chart for 100 mb (ref. 16) for build-up to 5 or 2 mb, or a 10-mb chart for build-up to 0.4 mb [in the examples shown, the 100-mb height field (Fig. 3) was added to the thickness pattern (Fig. 2) to obtain a first approximation height field for the 2-mb chart (Fig. 4)].

Relationships between radiance and temperature at 5, 2, and 0.4 mb were also sought. A weaker physical relationship exists between radiance and the temperature at any particular level than exists between radiance and the mean layer temperature or thickness. However, it was found that SCR channel 1 and SCR channel 2 specified the temperature at 5 and 2 mb to a good approximation (RMS error, approximately 8°C). These relationships are shown in Fig. 1b. The temperature patterns obtained by relabeling the appropriate SCR radiance charts were then used as a first guess in deriving the 5- and 2-mb temperature analyses.

ANALYSIS PROCEDURE

The analysis procedure consisted in obtaining first-approximation temperature and height fields and then adjusting these fields to conform with the rocketsonde wind, height, temperature, and thermal-wind information. When satellite data were available, first-approximation fields were obtained using the methods discussed in the previous section. On those occasions when satellite data were not available, conventional techniques were used to construct the temperature field, first at 5 mb; then differential analysis methods were used to obtain the height fields. Once the 5-mb fields were completed, the fields at 2 mb, then at 0.4 mb were built in a similar manner.

The analysis systems consisted of the following steps:

a. Isotherms were derived with the primary use of the plotted rocketsonde temperatures. Data acquired for each entire week were examined to determine the synoptic changes that took place during that week. Thus, conditions prevailing on Wednesday - the analysis day - were deduced. The SCR radiance data, when available, were especially useful in providing a first approximation to the temperature fields. Computed thermal winds were also very useful, especially for determining horizontal temperature gradients and the relative location of warm and cold areas. Time-height sections of temperature were consulted as a further aid in deriving the isotherms.

b. When satellite data were not available, a first-approximation height field was derived by differential analysis. A mean temperature field representative of the layer between the previously analyzed lower surface and the selected surface was derived graphically. This mean field represents a geopotential thickness which, when added to the lower level height field, yields a smooth, conservative first approximation to the contour pattern at the upper surface.

c. Reported winds and computed heights for individual stations were employed to adjust the first approximation of the contour field, assuming geostrophic flow. Winds were accorded the highest priority for this adjustment. When large adjustments were made to the contour field, the temperature field was necessarily adjusted to maintain hydrostatic consistency.

d. The analyses were reviewed for vertical and temporal consistency. For example, circulation centers, ridges, and troughs were examined with the aid of all available data to verify vertical slope and movement with time. Time-height sections and height-change charts were especially useful for those purposes.

The above procedures, primarily those including the use of satellite data produced good results at 5 mb and 2 mb, and were successfully applied to obtain the 0.4-mb charts. Generally, the adjustments to the first-approximation height fields by the addition of rocket data at the 5- and 2-mb levels were not large. However, more formidable analysis problems were evident at the 0.4-mb level, especially when satellite data were not available.

One problem arises from the apparent intersection of the stratopause with the 0.4-mb level. Because the normal stratospheric temperature inversion ceases at the stratopause level, the graphical method for obtaining mean temperature, which depends on the existence of a linear profile, is no longer valid. Large adjustments must be made in the graphically derived height fields, especially at lower latitudes, for the sake of conformity with the computed height at each station.

Another difficulty was the apparent occurrence of large day-to-day temperature changes, at times exceeding 10°C (ref. 17), and persistent oscillations in many wind profiles. In most cases, deviations of reported temperatures and winds from one another could be accounted for by identifiable rapid large-scale synoptic changes. Sometimes rocketsonde reports within a few hours of each other at a single station exhibited temperature changes of 5° to 7°C over a limited height interval near the stratopause. It has been shown that such small-scale subsynoptic changes are possible at these levels (ref. 18). Thus, some intermediate value was chosen for analysis to represent the value on the analysis day. Occasionally, it was impossible to make a reasonable reconciliation of reported station values.

Although careful consideration of high-level data allows a broadscale depiction of circulation patterns up to 0.4-mb, the sparsity of reports requires increasing subjectivity as the analysis proceeds to this level. The justification for some analyses depends on the interpretation of the limited amount of data in such a way as to portray a coherent sequence of synoptic events. In spite of these factors, surprisingly little alteration in the principal features of the circulation and temperature distribution shown in the final analysis can be made without inordinately violating some of the data. In general, the contours and isotherms depicted are felt to be good approximations to the flow and temperature patterns at this level. Even so, the same degree of accuracy that is found customarily in the analysis of charts at lower levels should not be expected.

A contour interval of 320 geopotential meters was used throughout the year. In addition, intermediate dashed contours were used to outline areas of relatively weak gradient, especially during the spring and fall changeover periods. Isotherms were drawn and labeled at 5°C intervals.

DISCUSSION OF THE JULY 1973-JUNE 1974 CIRCULATION

Careful inspection of the 5-, 2-, and 0.4-mb Northern Hemisphere charts will give the viewer a good indication of the middle and upper stratosphere circulation for the year from July 1973 through June 1974. In this brief discussion, a few of the most interesting circulation events will be highlighted along with a general description of the seasonal changes that took place during the year.

Summer stratospheric circulation is characterized by a warm core anticyclone centered near the Pole with fairly steady easterlies throughout the hemisphere at middle and high latitudes. Maximum polar temperatures as well as maximum easterlies are regularly seen in mid-July and may be noted on the charts for 18 July 1973. Westerly winds associated with a cold subtropical trough may be seen on the 18 July 0.4-mb chart. The decrease of easterly winds above 2 mb in the vicinity of Ft. Sherman may be inferred from thermal wind considerations, since cold air is located to the north of that station on the 2-mb chart. The increase of easterly wind up to 0.4 mb at the higher latitudes may likewise be anticipated in association with the increase of temperature with increasing extratropical latitudes. Smaller scale circulation features may also be inferred by noting the variation of wind and temperature reported at each rocketsonde station and represented by up to three reports from each station during the week of 16-20 July.

Transition from stratospheric summer circulation is indicated by weakening of the easterly circulation. The charts for 15 August indicate a decrease in temperature and diminishing height of the polar anticyclone when compared with July charts. By 12 September cyclonic circulation was evident in the polar region at the 5-, 2-, and 0.4-mb levels. Anticyclonic cells were displaced southward as cyclonic westerlies intensified during September and October and became dominant throughout middle and high latitudes.

Wintertime stratospheric circulation, characterized by a cold intense polar vortex became firmly established by 3 October. Perturbations in the nearly circumpolar westerlies and temperature field are apparent, beginning in early winter and increasing in amplitude throughout the winter.

As an aid for evaluating the changes that took place at various locations, Figures 5-10 show time sections of analyzed height and temperature values extracted from the charts. During the autumn and early winter, the lowering of temperatures and heights of the pressure surfaces at the northern locations (Poker Flat, Churchill, Volgograd, and Wallops) are readily apparent (Figs. 5-8). Perturbations in the height and temperature traces

are readily discernible. For instance, the small height rises seen in the time sections for Poker Flat and Churchill (Figs. 5 and 6) on 7 November were associated with a minor shift of the trough axis over the western United States. The time sections show that the amplitude of wintertime perturbations diminishes significantly at low latitude stations, with White Sands and Antigua (Figs. 9 and 10) indicating rather small changes throughout the entire year.

The temperature fields at 0.4 mb indicate large scale perturbations in the polar region beginning in early winter. The 0.4-mb chart for 31 October shows warm air dominating southern latitudes over most of Eurasia. Thereafter, the 0.4-mb temperature fields exhibit major perturbations. On November 28 warm air is also indicated over the Pole at 2 mb. By the beginning of December, warm air at 0.4 mb had become dominant over the polar region to remain there throughout the remainder of the winter. From hydrostatic considerations, it is apparent that the intensity of the polar cyclone diminished with height above the level at which the vortex changed from cold-core to warm-core.

At the end of December and during early January, a relatively major disturbance of the height field occurred and affected the entire polar region. The changes that took place at six representative locations may be seen from the time sections (Figures 5-10). The 2 January 1974 constant-pressure charts for 5- and 2-mb surfaces indicate a large intense anticyclone covering a wide area between North America and Asia. It is interesting to note the phase relationship between the contours and isotherms at the various pressure levels. For example, at 5 mb the normal relationship between the cold air and cyclone and warm air and anticyclone is evident. At 2 mb, however, the phase was almost reversed with cold air nearly overlying the Aleutian anticyclone (not an uncommon feature of the very active 2-mb level). This reversal resulted in diminishing the anticyclone with height and the rather complete disappearance of a closed anticyclonic circulation from the 0.4 mb chart of 2 January.

Another perturbation in the height fields at all levels is seen in late February. Precursors may be noted on the charts throughout January and February. However, the radical change indicated between the 0.4-mb charts for February 20 and 27 illustrates the large-scale changes that occurred throughout the stratosphere.

During the months of March and April, the changeover from westerly circulation to the warm polar easterlies of summer took place. The changes in early March appeared to be dominated by large-scale dynamic interactions. However, around the time of the vernal equinox, the distinction between the dynamic changes associated with winter warmings and those due to increasing solar

heating of the polar area became less apparent. The dominance of weak westerly flow at 0.4 mb as late as April 3, 1974, at the same time that the 5- and 2-mb levels indicated polar easterlies, suggests that dynamic changes still played a major role. The change to summer conditions was substantially completed by the end of May.

ACKNOWLEDGMENTS

We are grateful for the cooperation of D. Wark and A. Stefancik of the National Environmental Satellite Service for providing VTPR satellite radiance data and to J. Houghton of Clarendon Laboratory, Oxford, England for providing SCR information.

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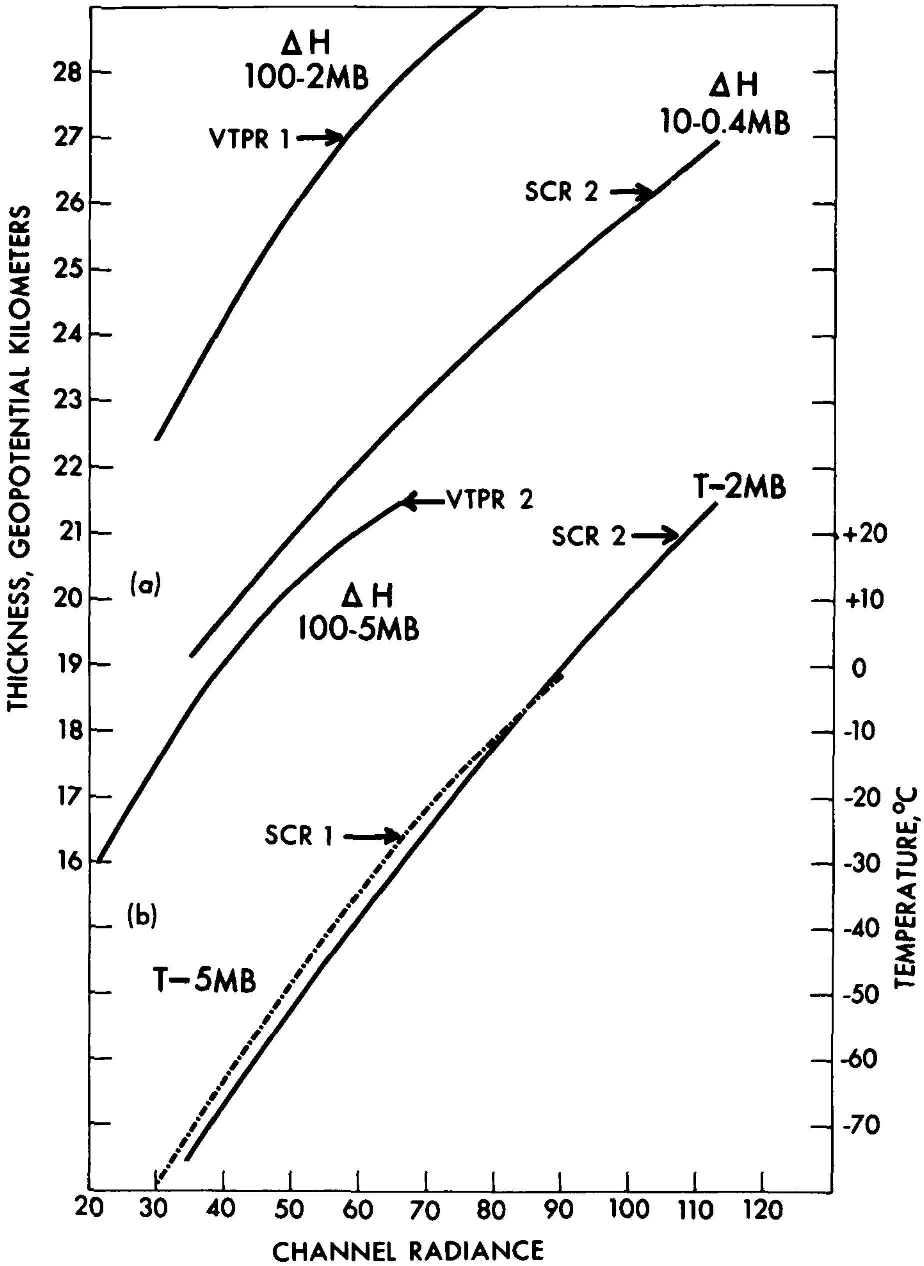


Figure 1. Relationships between satellite-measured radiances and thickness (a); and between radiance and temperature (b). The following relationships are shown: VTPR (NOAA 2 and 3) channel 1 for thickness between 100 to 2 mb; VTPR channel 2 for thickness between 100 to 5 mb; SCR (Nimbus 5) channel 2 for thickness between 10 to 0.4 mb; SCR channel 1 for temperature for 5 mb; and SCR channel 2 for temperature at 2 mb. Radiance units 10^{-7} J. cm^{-2} . s^{-1} . $(ster)^{-1}$. $(cm^{-1})^{-1}$.

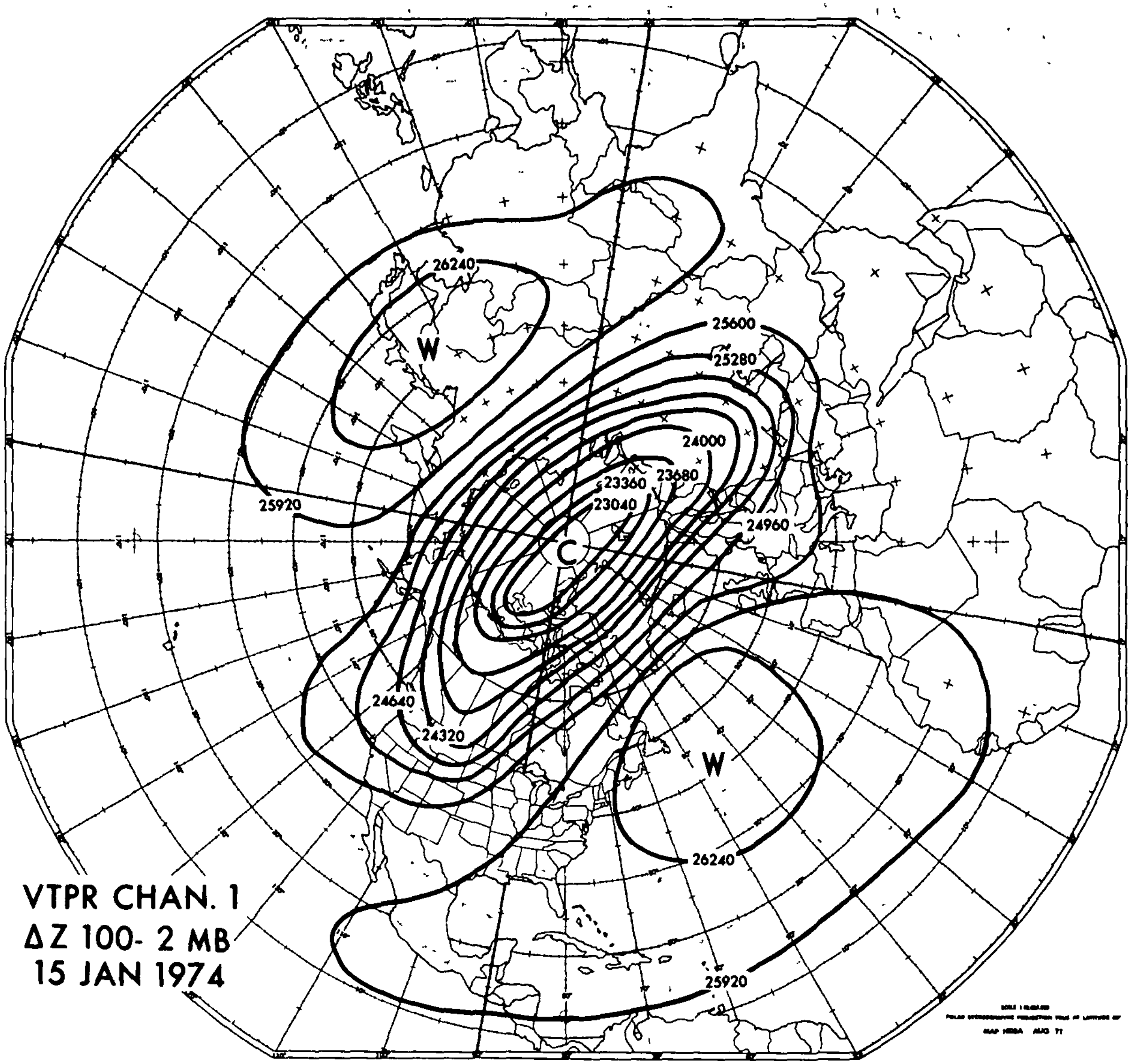


Figure 2. Thickness (geopotential meters) between 100 to 2 mb for 15 January 1974, derived by relabeling VTPR channel 1 radiance chart. Cold (C) and warm (W) air centers are noted.

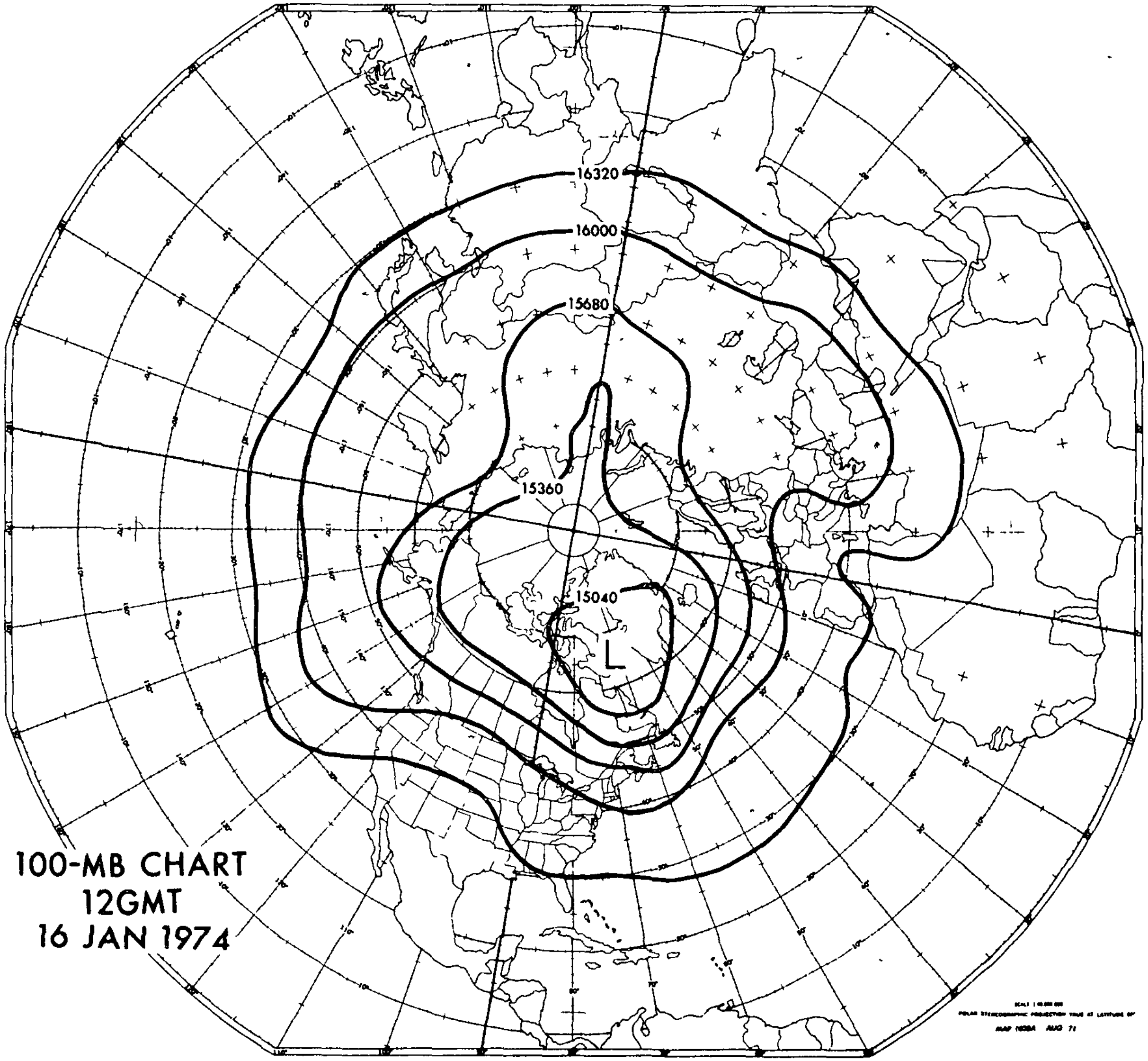


Figure 3. Height (geopotential meters) of the 100-mb surface for 16 January 1974, produced by the National Meteorological Center, NOAA.

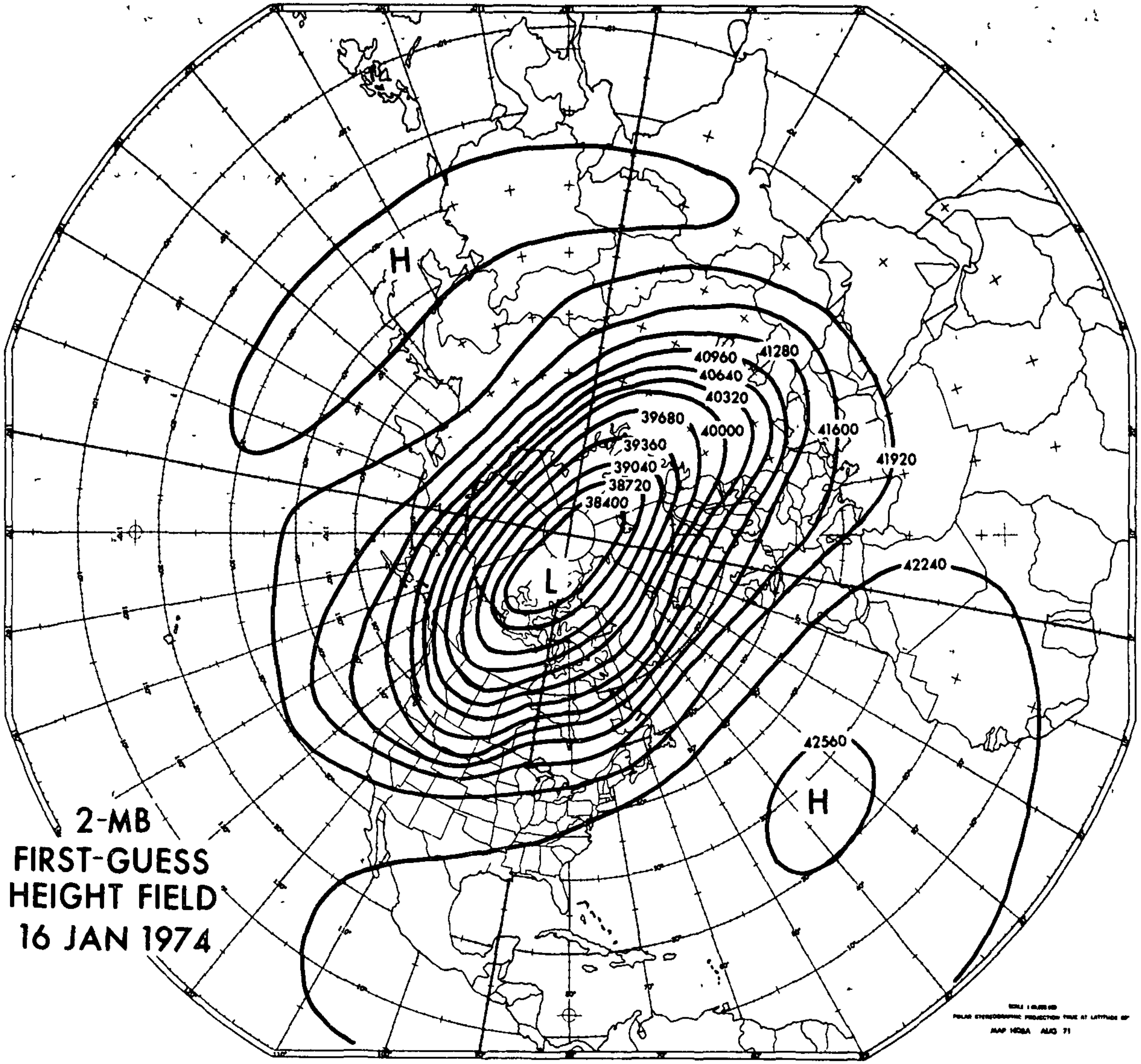


Figure 4. Height (geopotential meters) of the 2-mb surface for 16 January 1974, used as first approximation height field to be adjusted to take account of rocketsonde data.

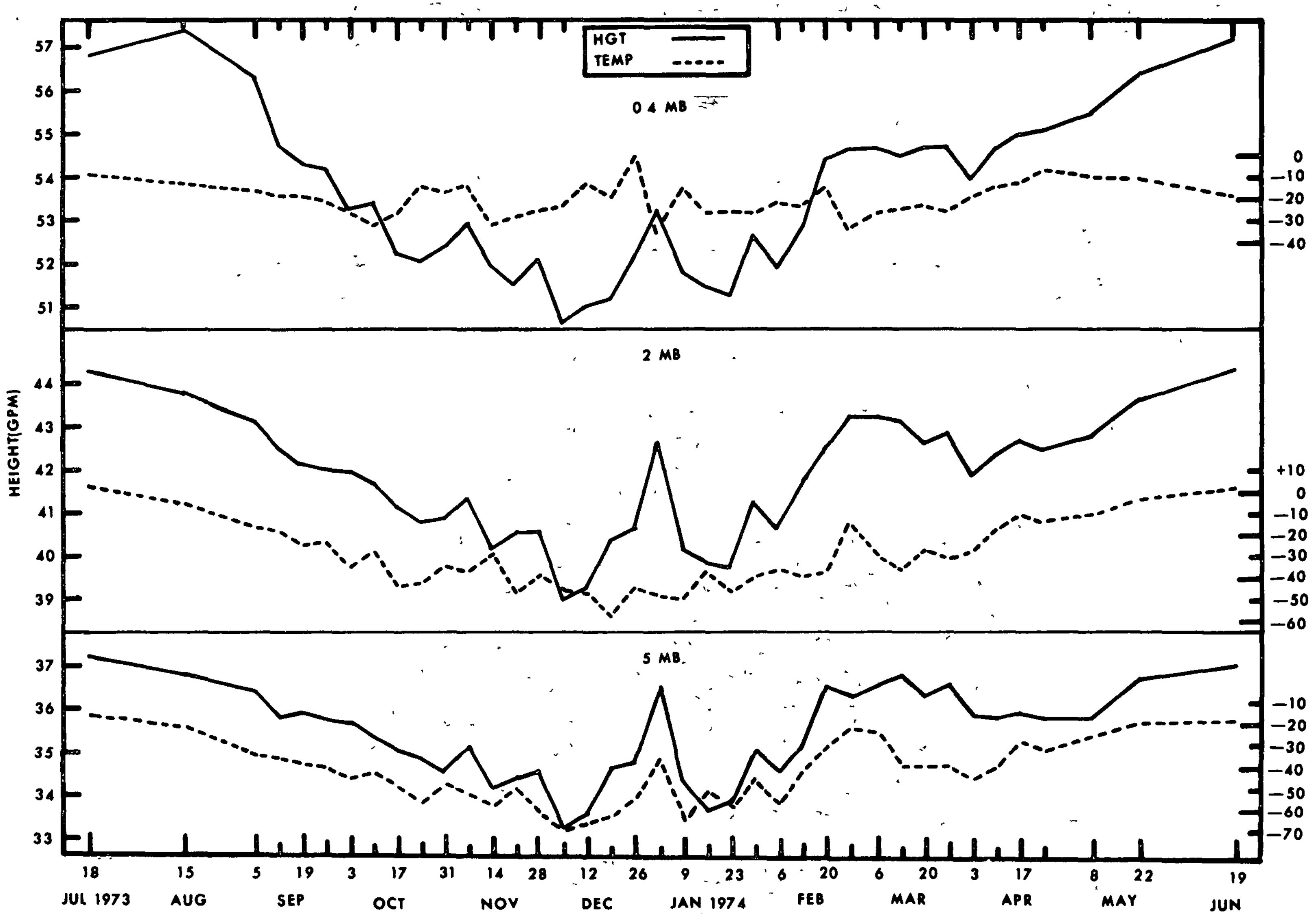


Figure 5. Poker Flat, Alaska (65°07'N, 147°29'W) analyzed values extracted from the 5-, 2-, and 0.4-mb charts for July 1973 to June 1974.

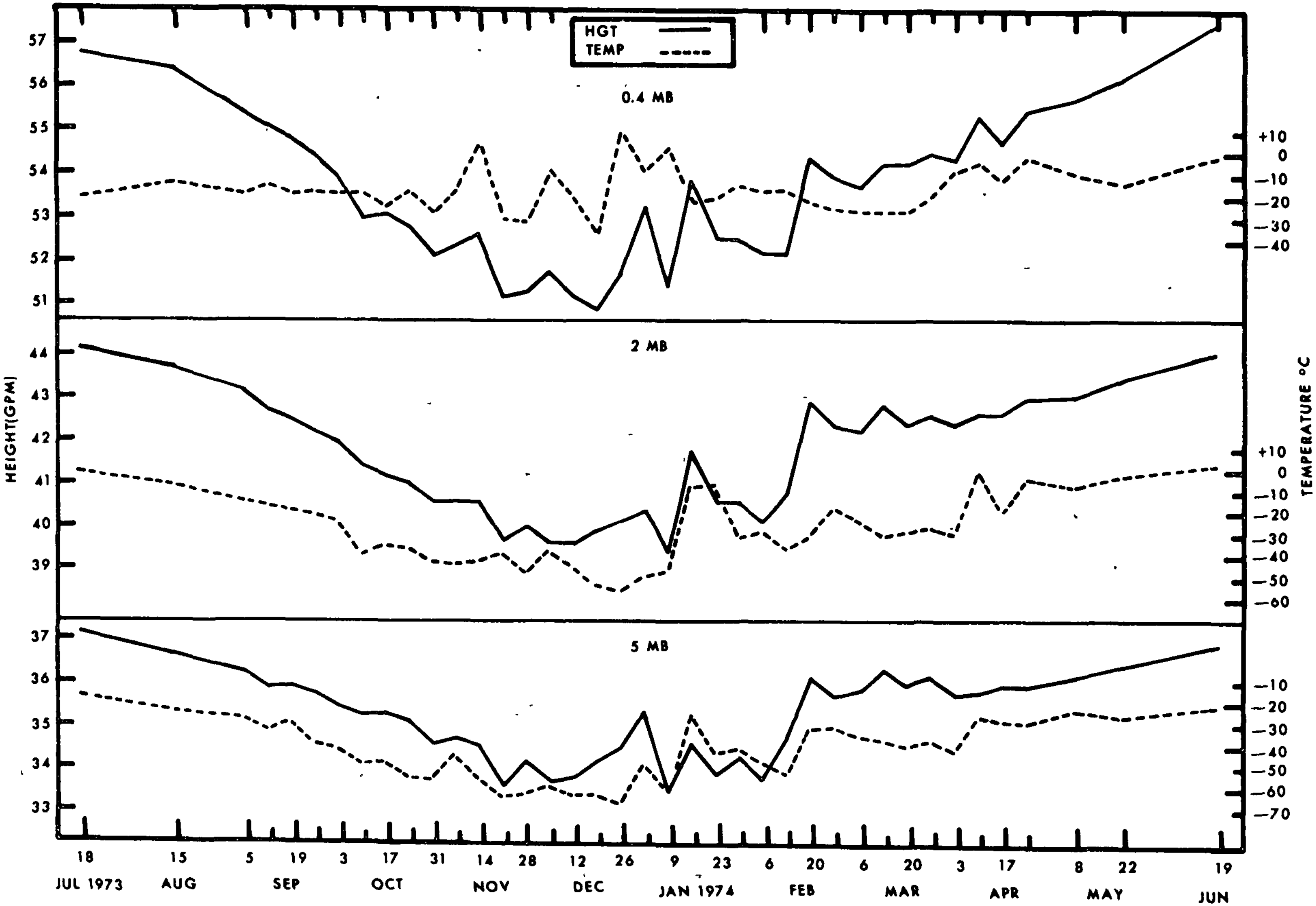


Figure 6. Fort Churchill, Canada (58°44'N, 93°49'W) analyzed values extracted from the 5-, 2-, and 0.4-mb charts for July 1973 to June 1974.

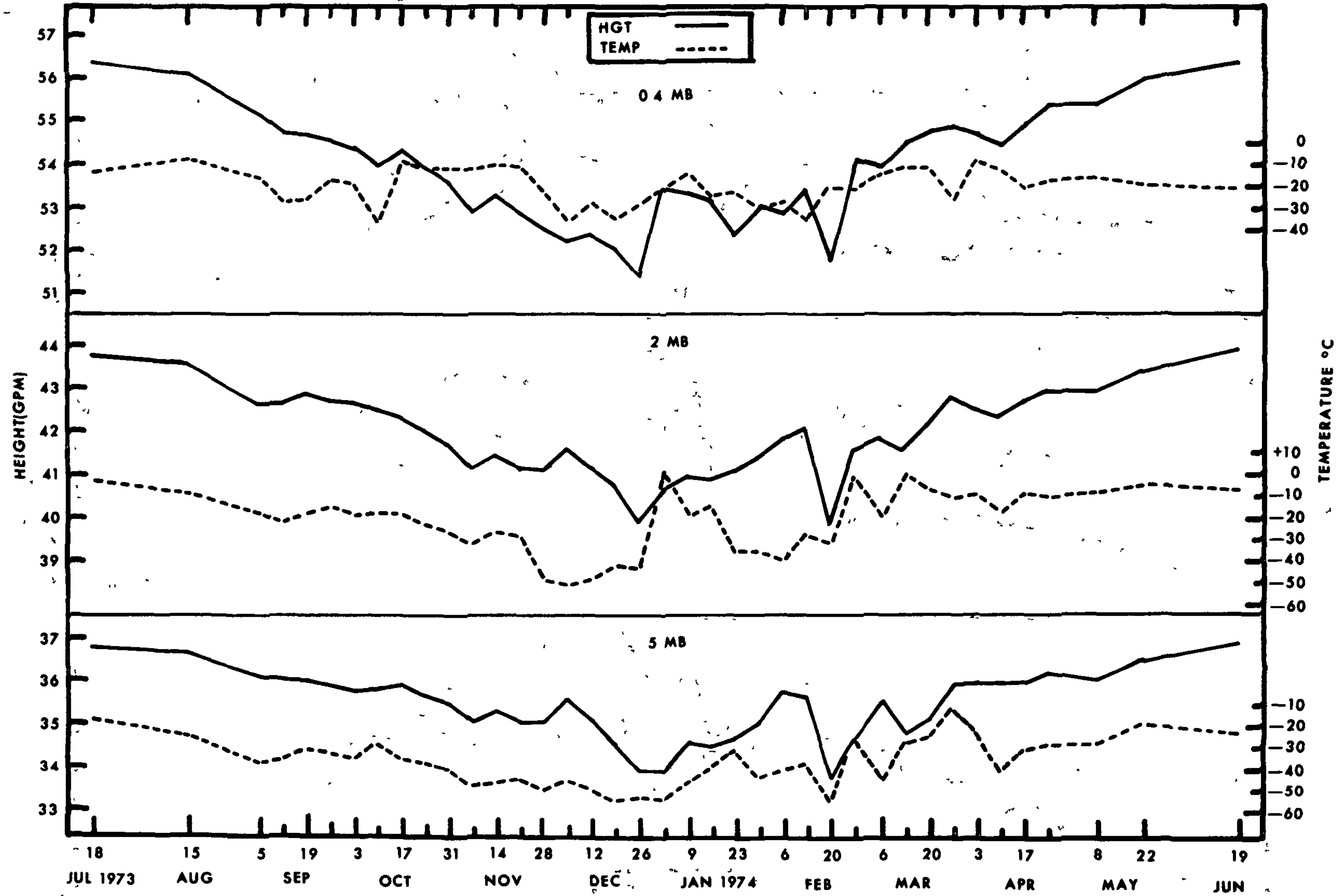


Figure 7. Volgograd, U.S.S.R. (48°41'N, 44°21'E) analyzed values extracted from the 5-, 2-, and 0.4-mb charts for July 1973 to June 1974.

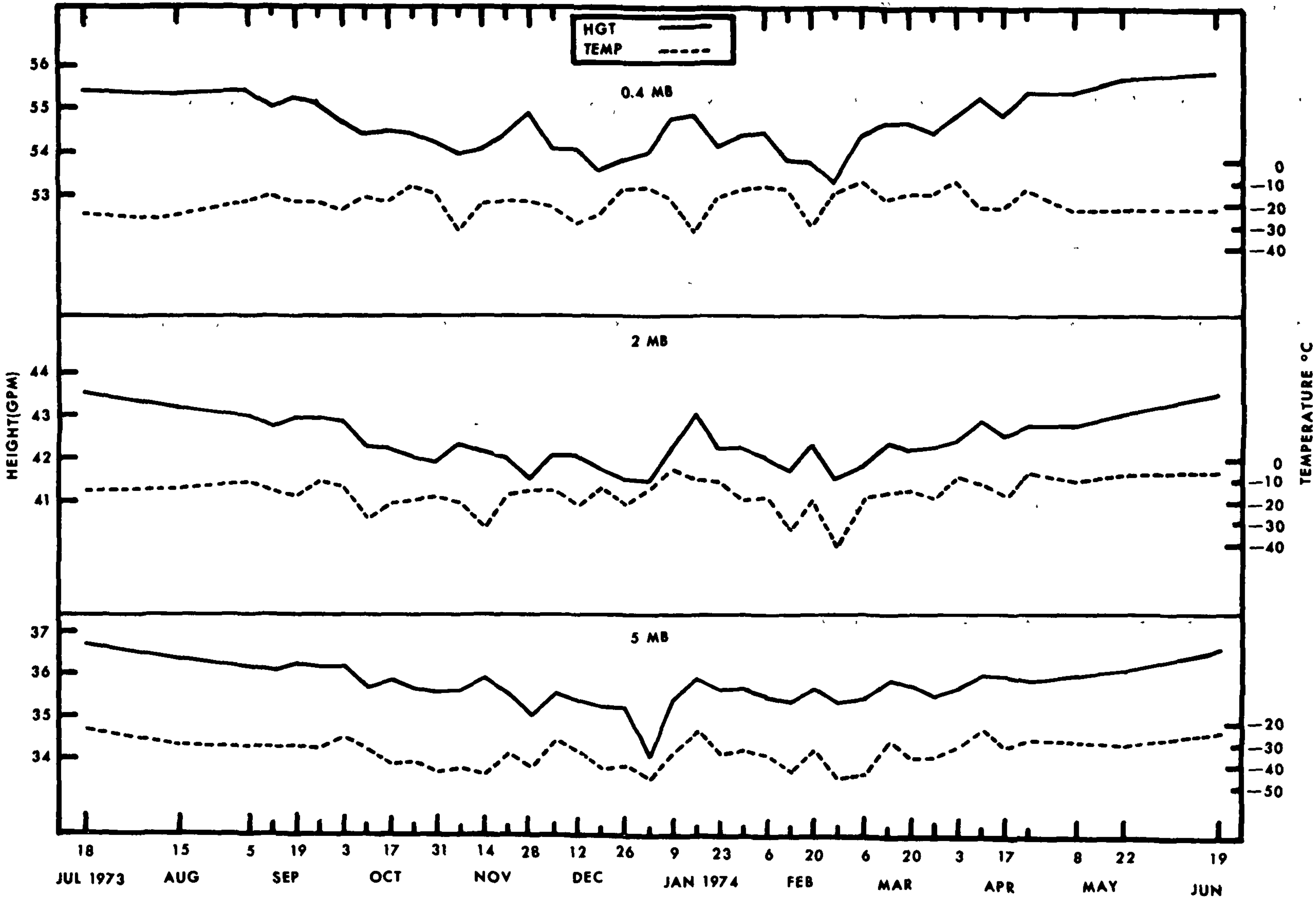


Figure 8. Wallops Island, Virginia (37°50'N, 75°29'W) analyzed values extracted from the 5-, 2-, and 0.4-mb charts for July 1973 to June 1974.

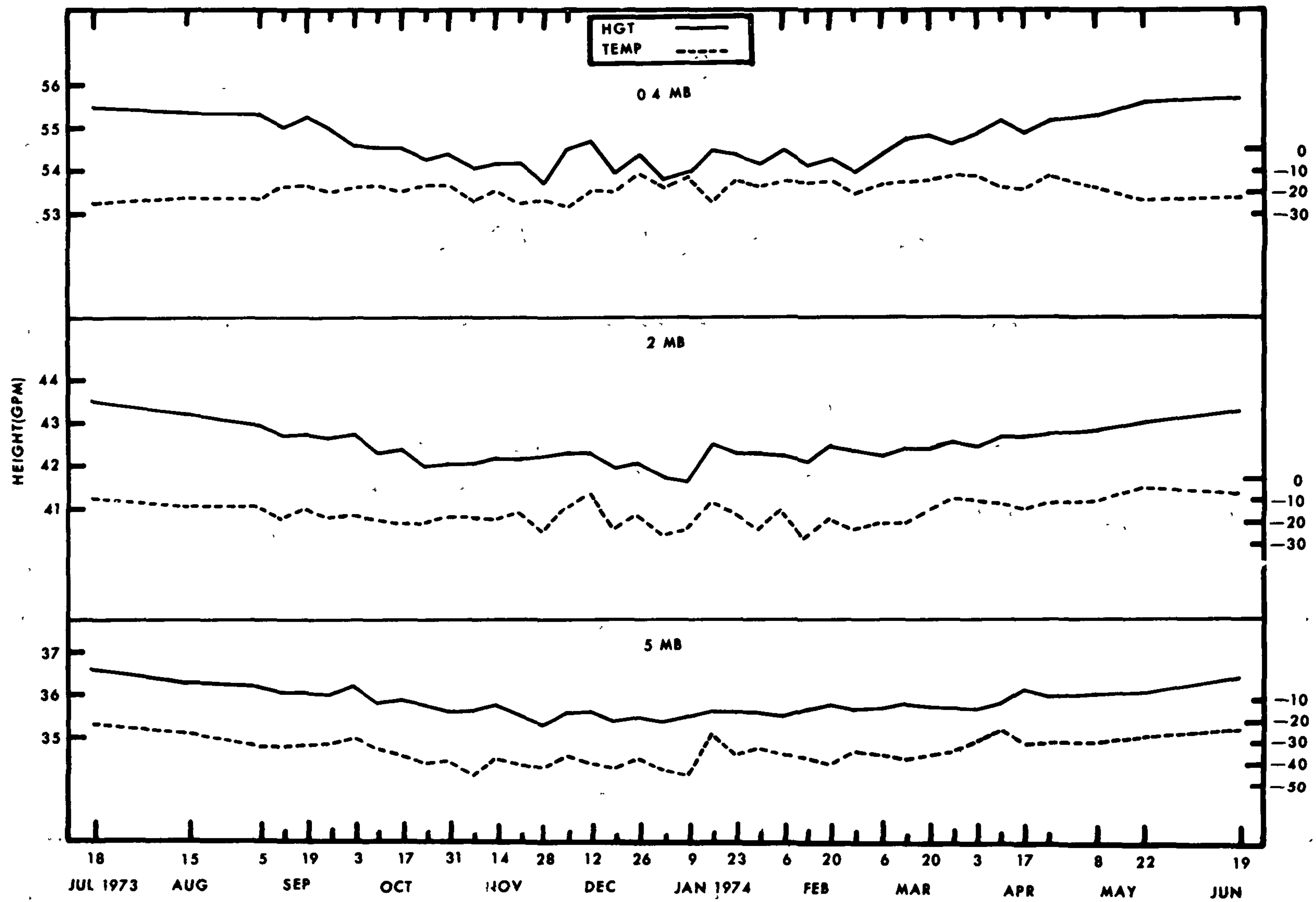


Figure 9. White Sands, New Mexico (32°23'N, 106°29'W) analyzed values extracted from the 5-, 2-, and 0.4-mb charts for July 1973 to June 1974.

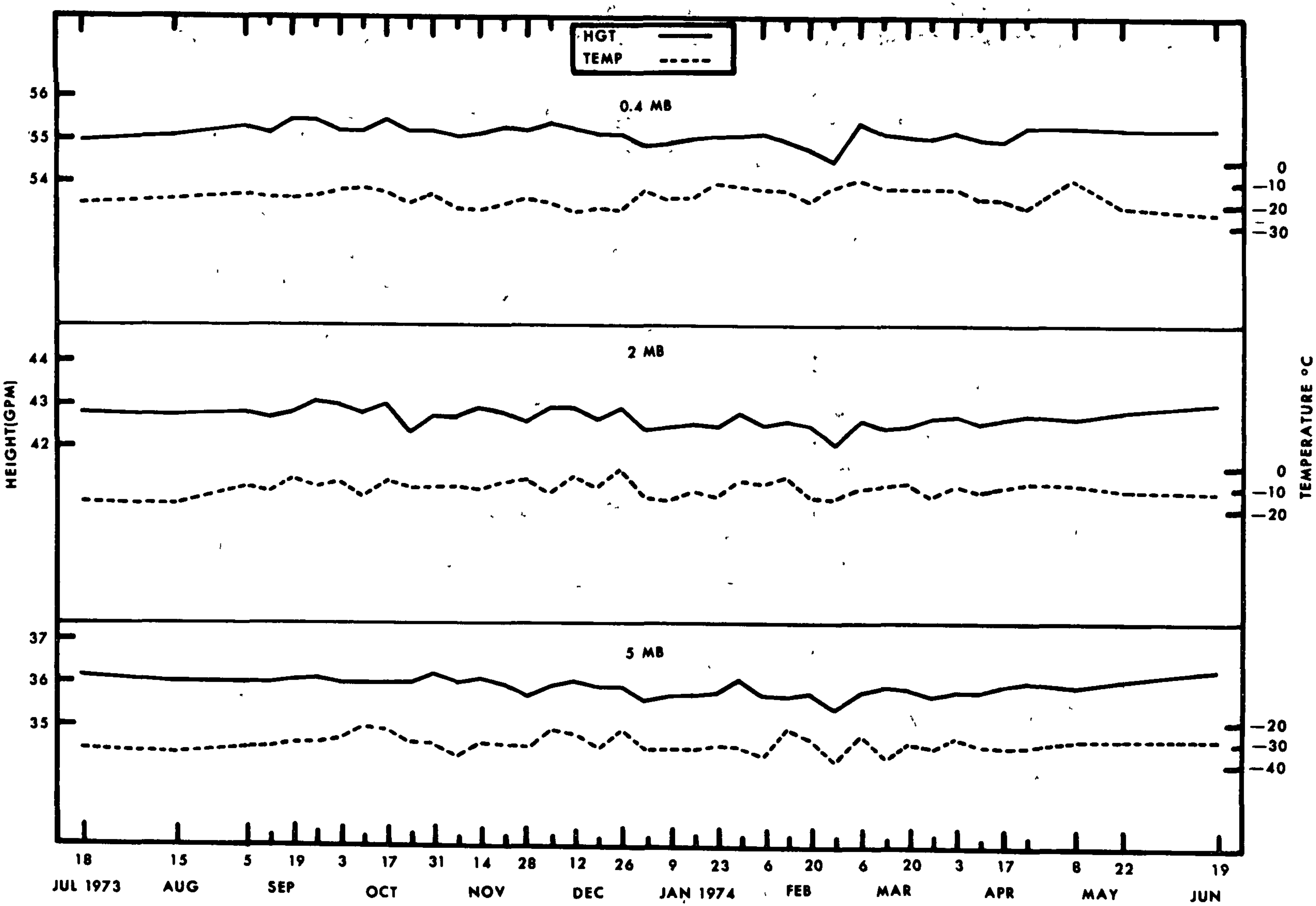


Figure 10. Antigua, W.I.A.S. (17°08'N, 61°47'W) analyzed values extracted from the 5-, 2-, and 0.4-mb charts for July 1973 to June 1974.

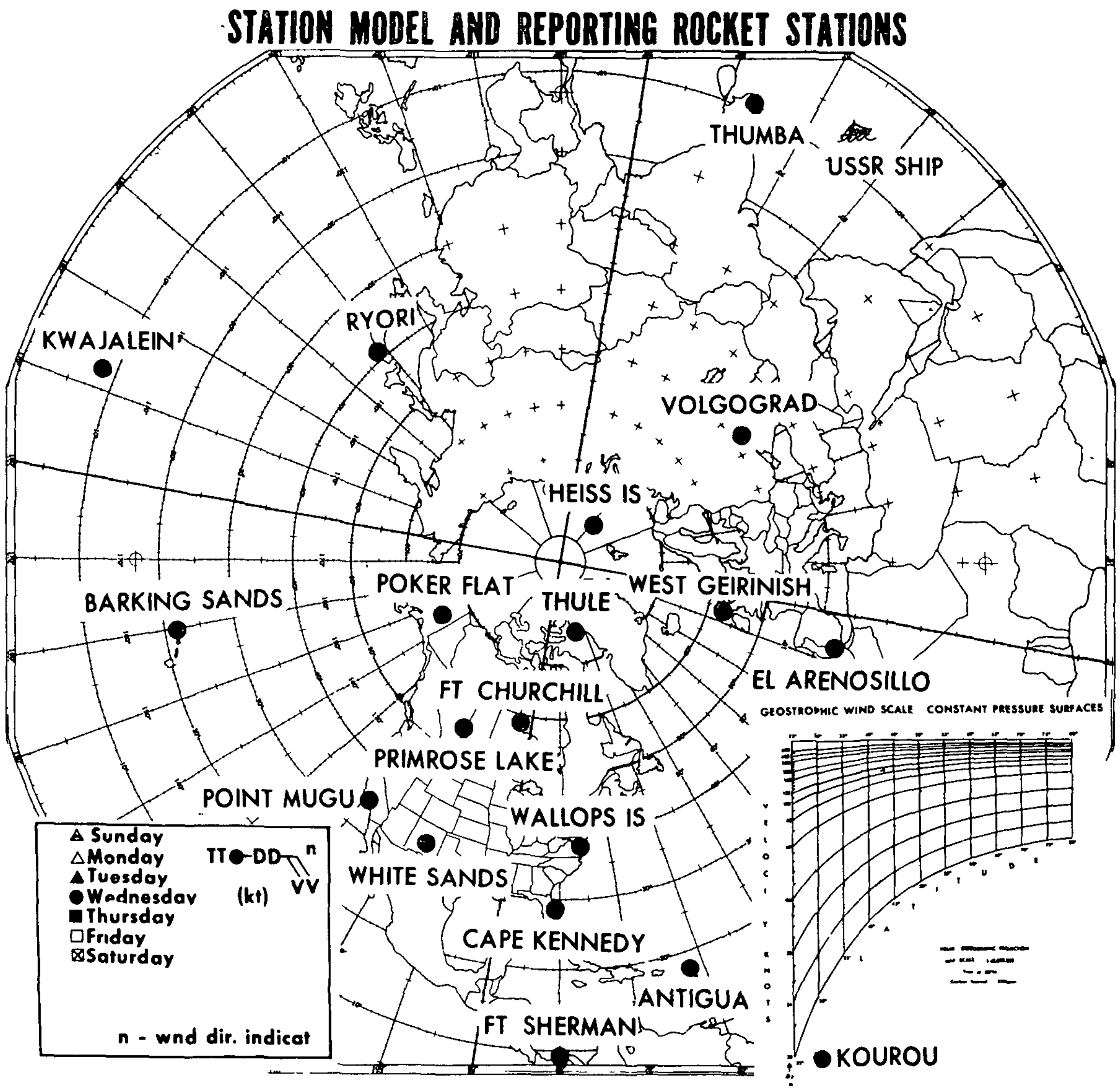
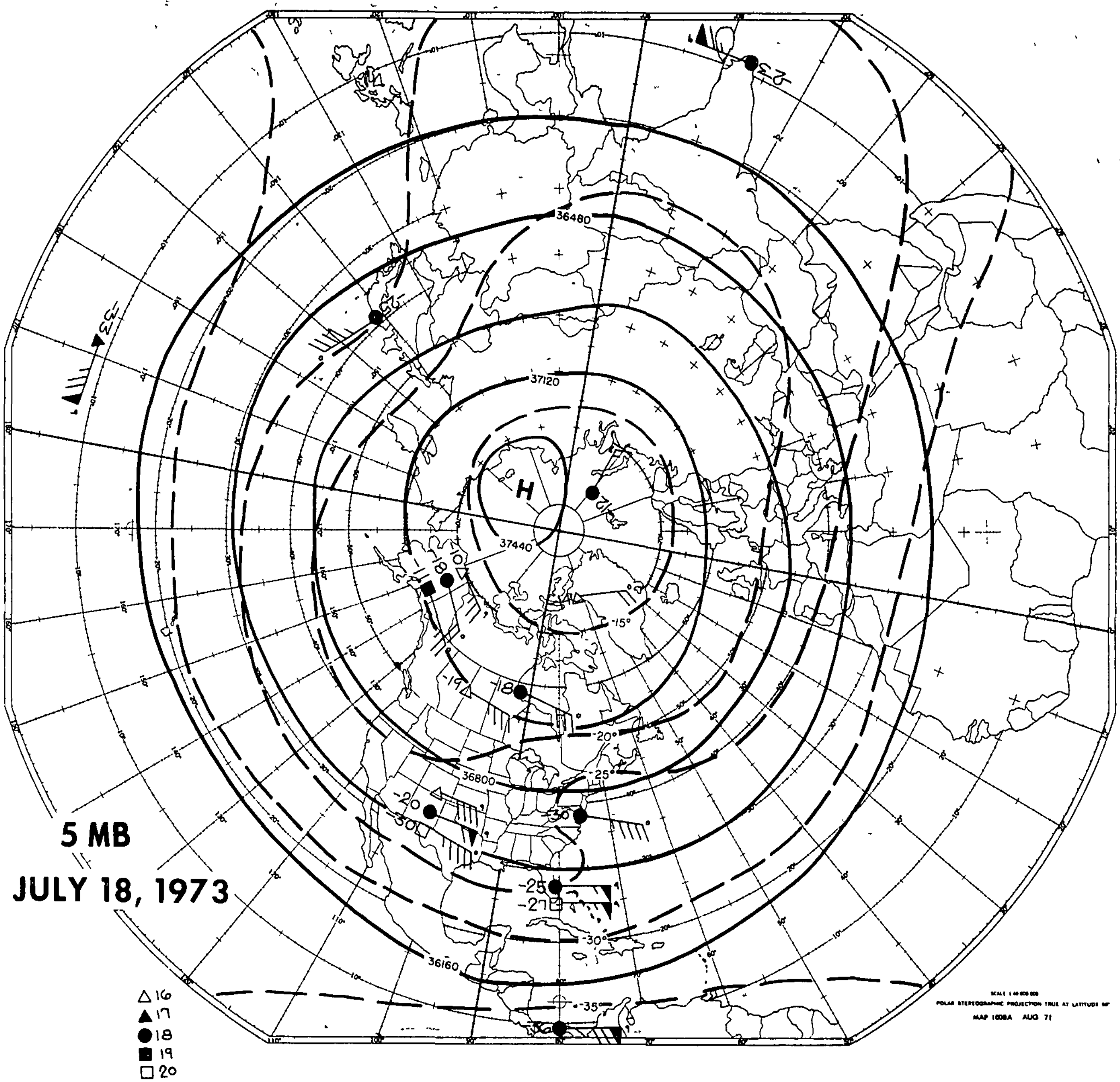


Figure 11. Northern Hemisphere map with locations of 19 rocketsonde stations and one mobile ship. Model for plotted rocketsonde data and a geostrophic wind scale are also shown.



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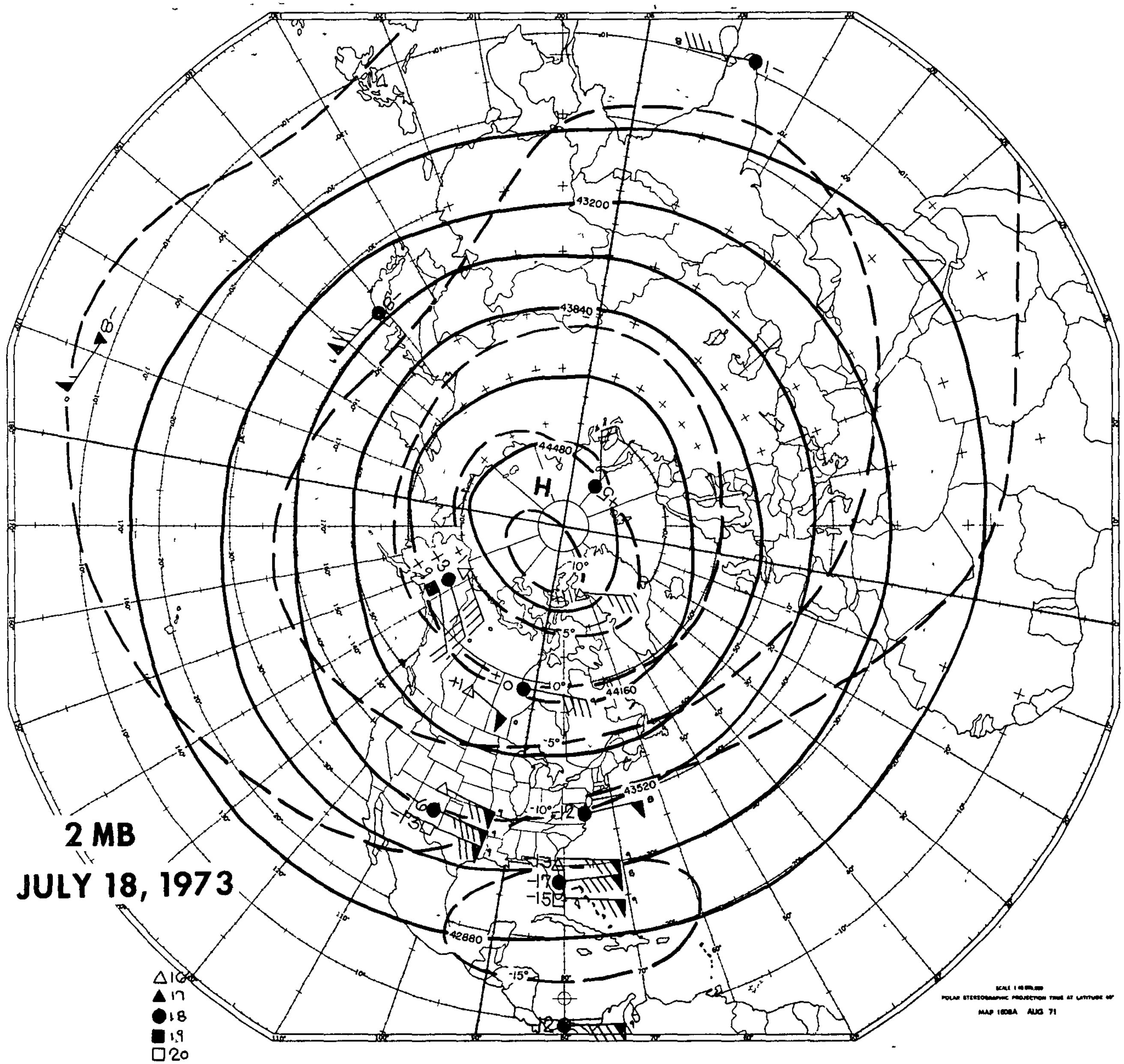

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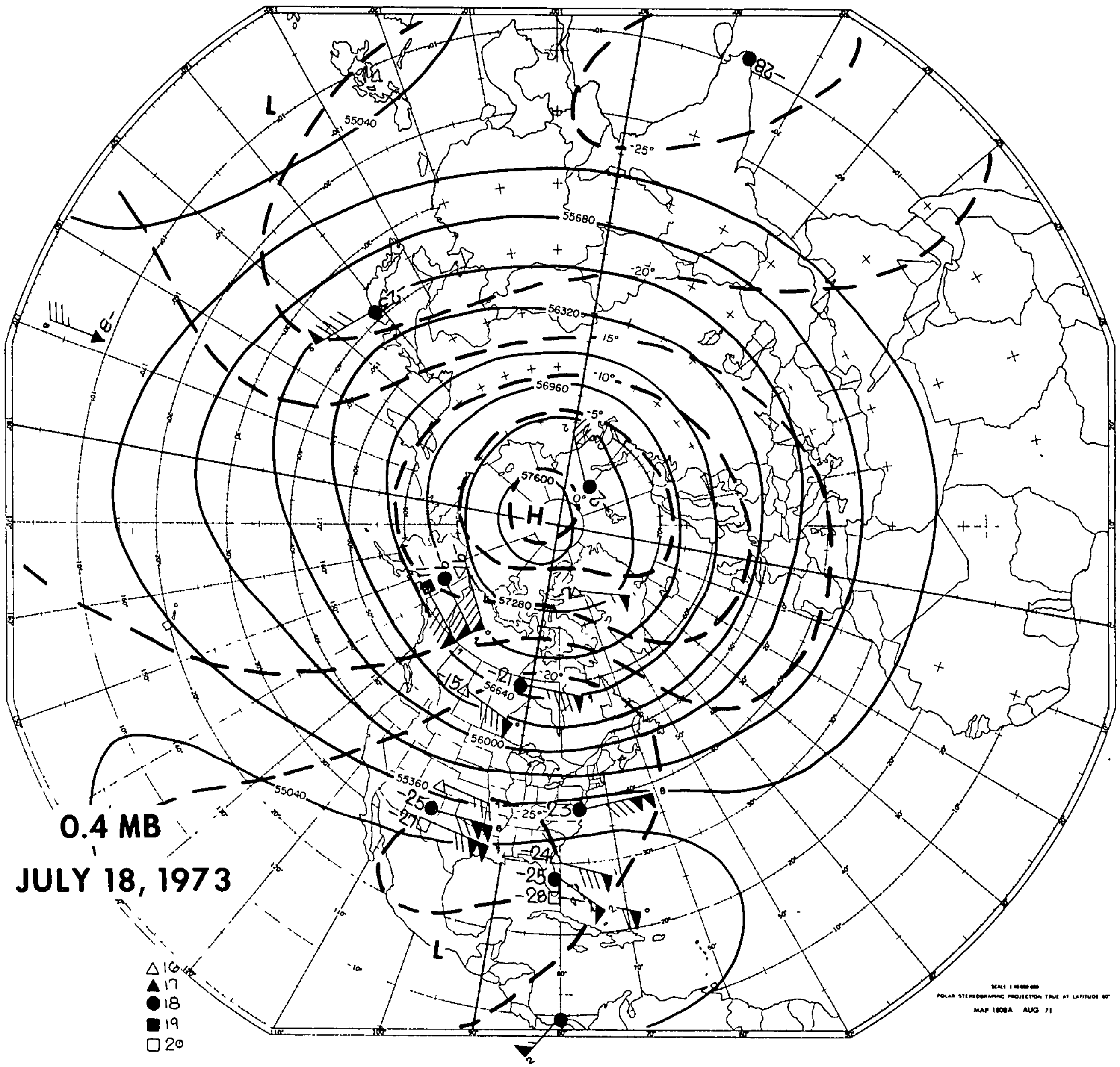
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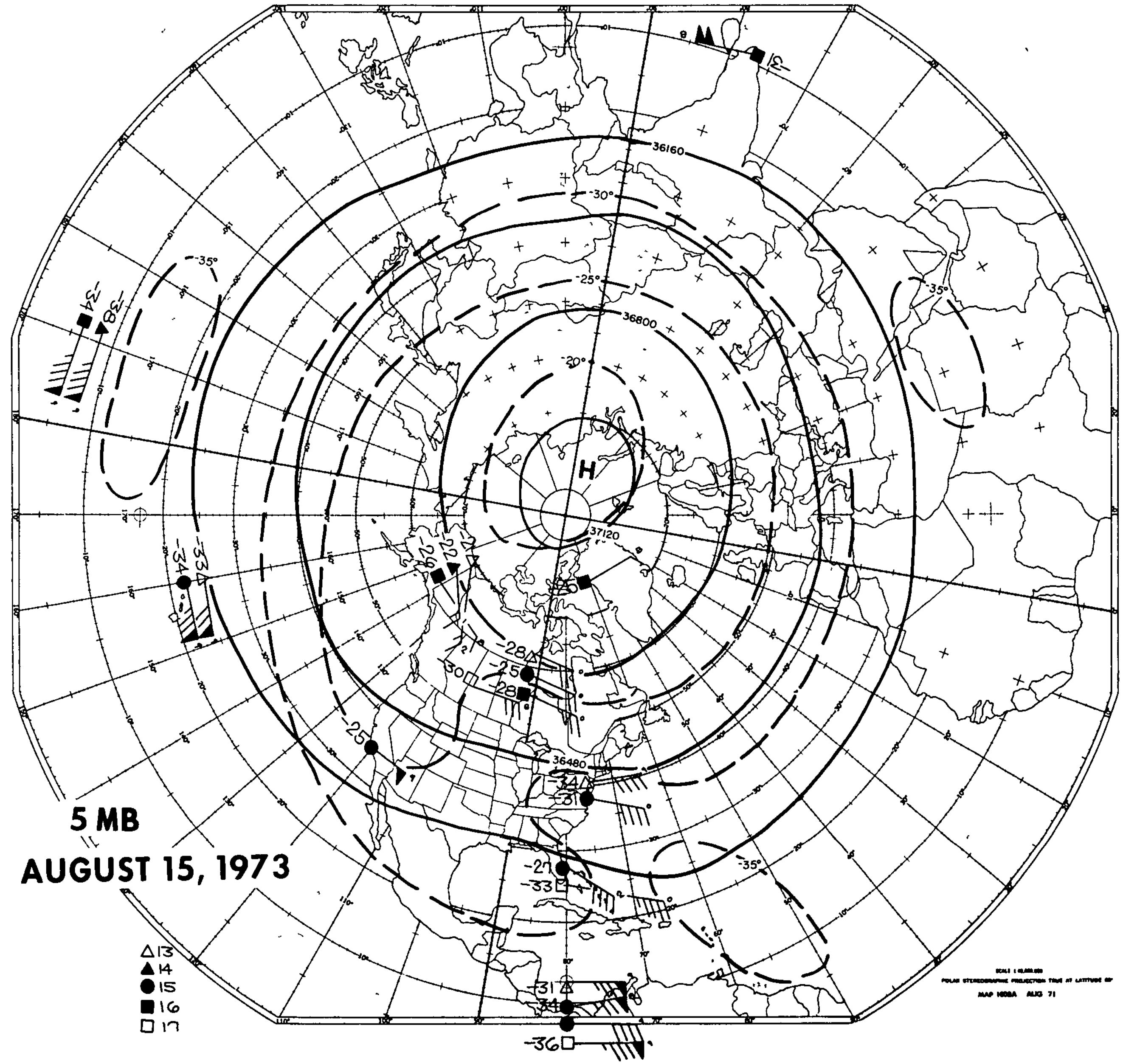

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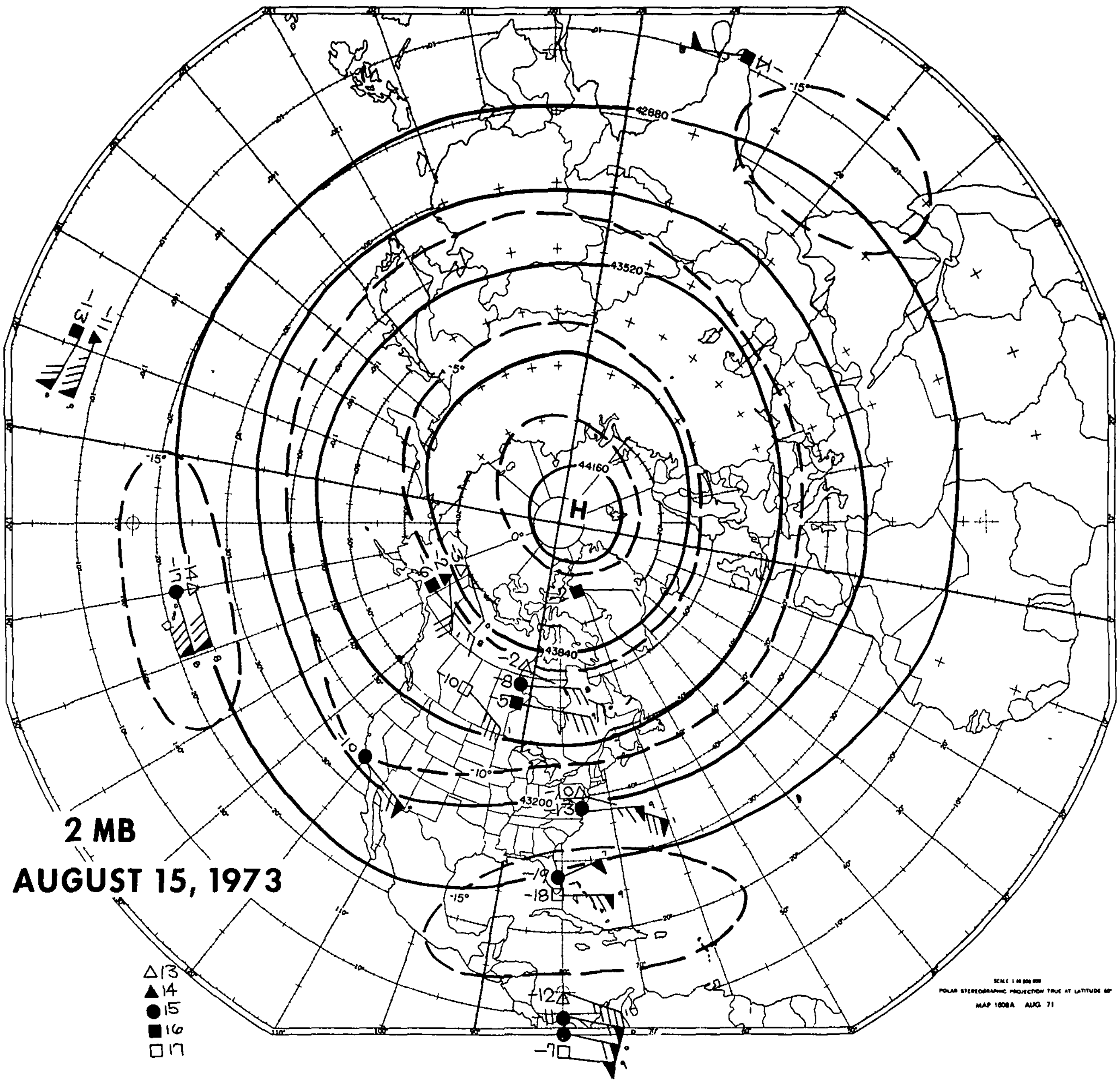

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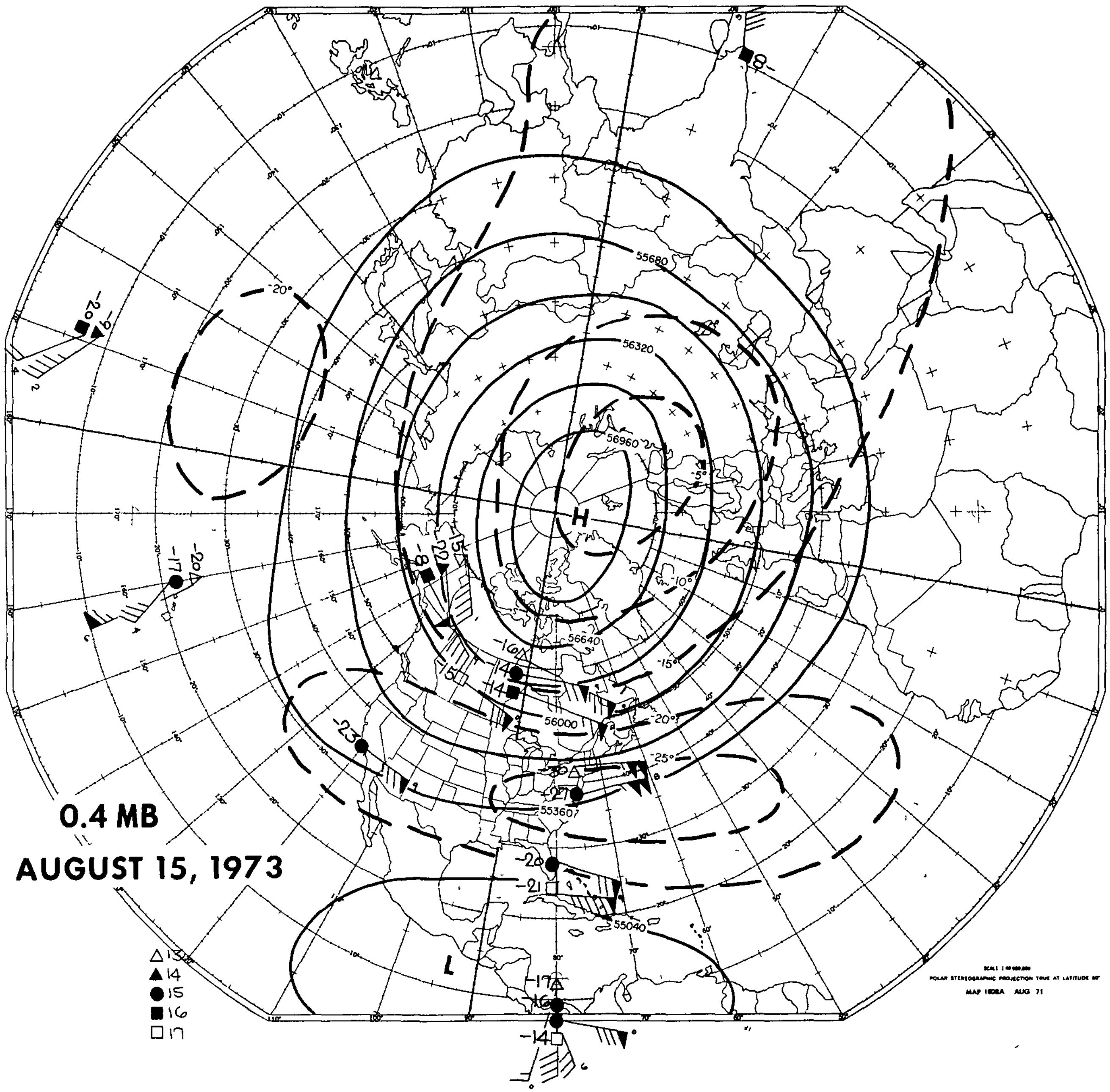

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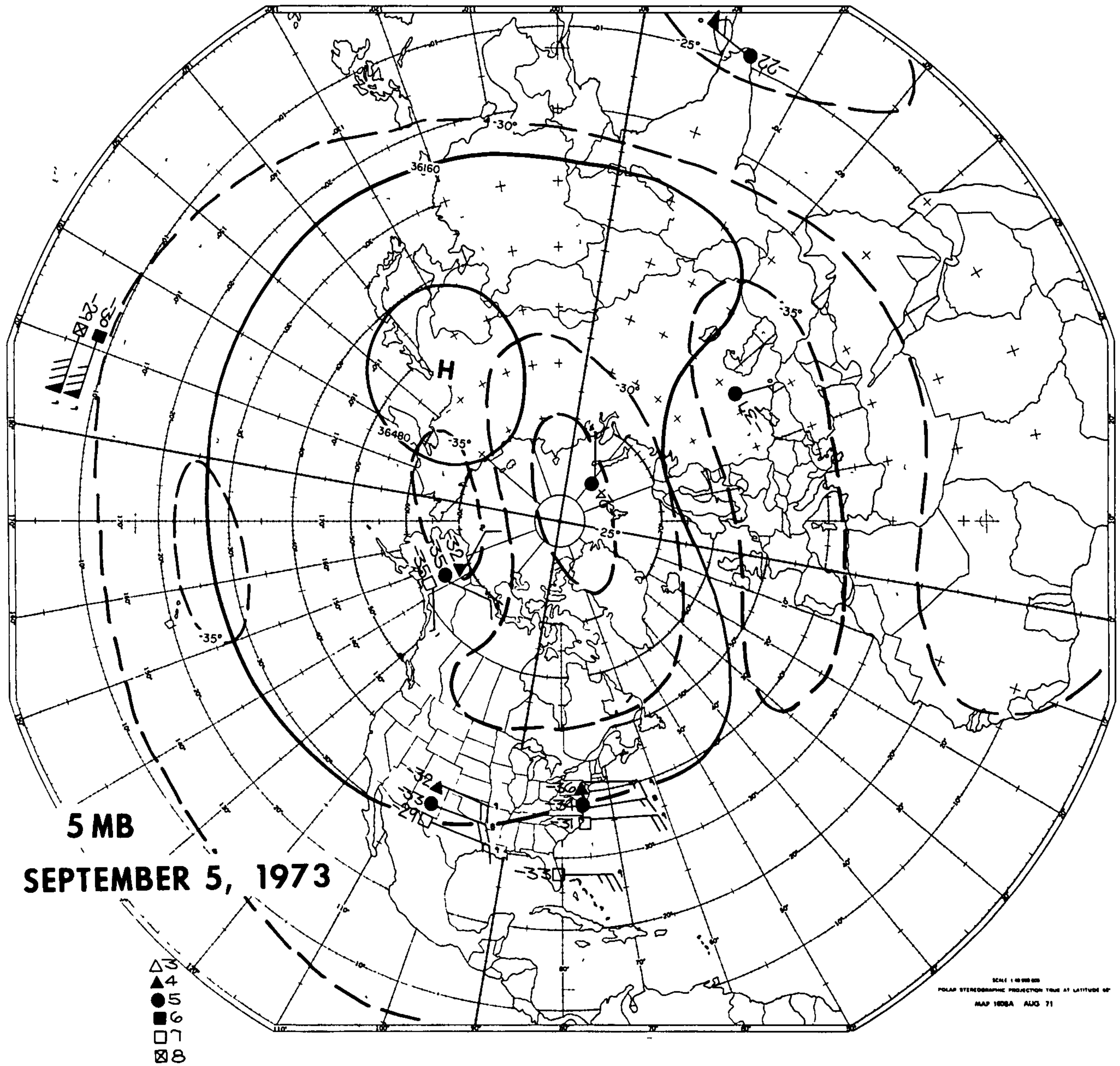

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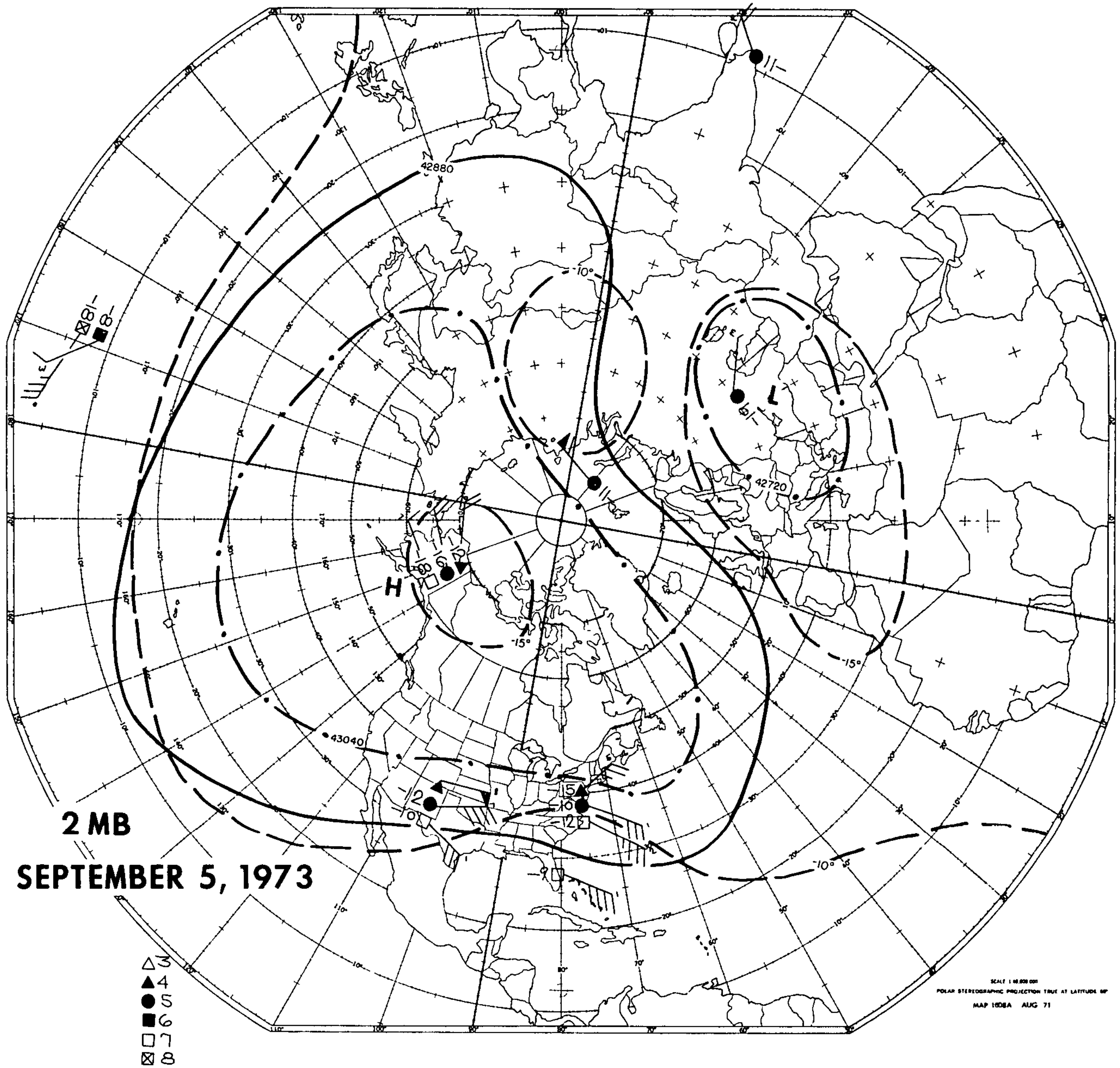

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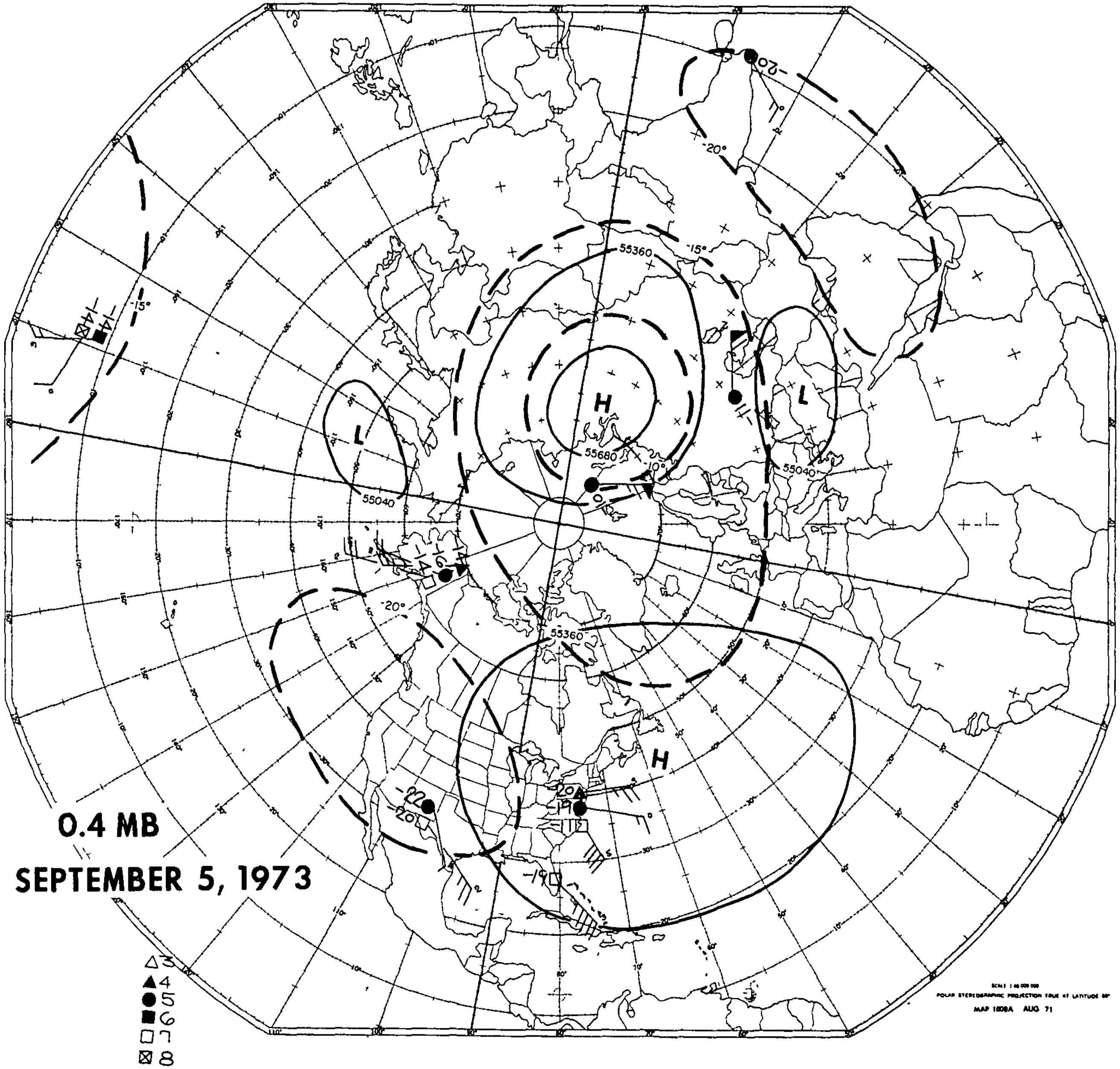

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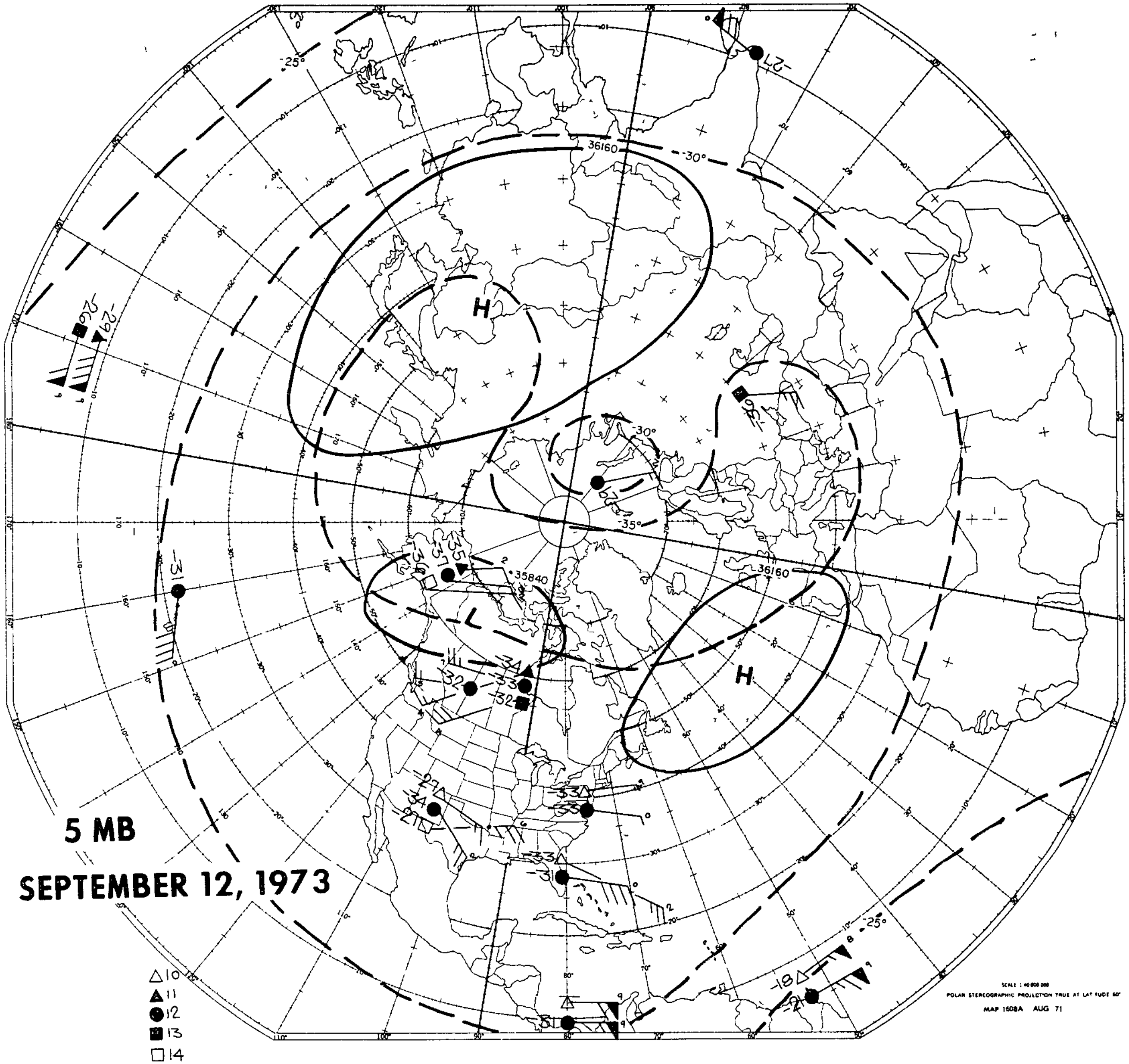

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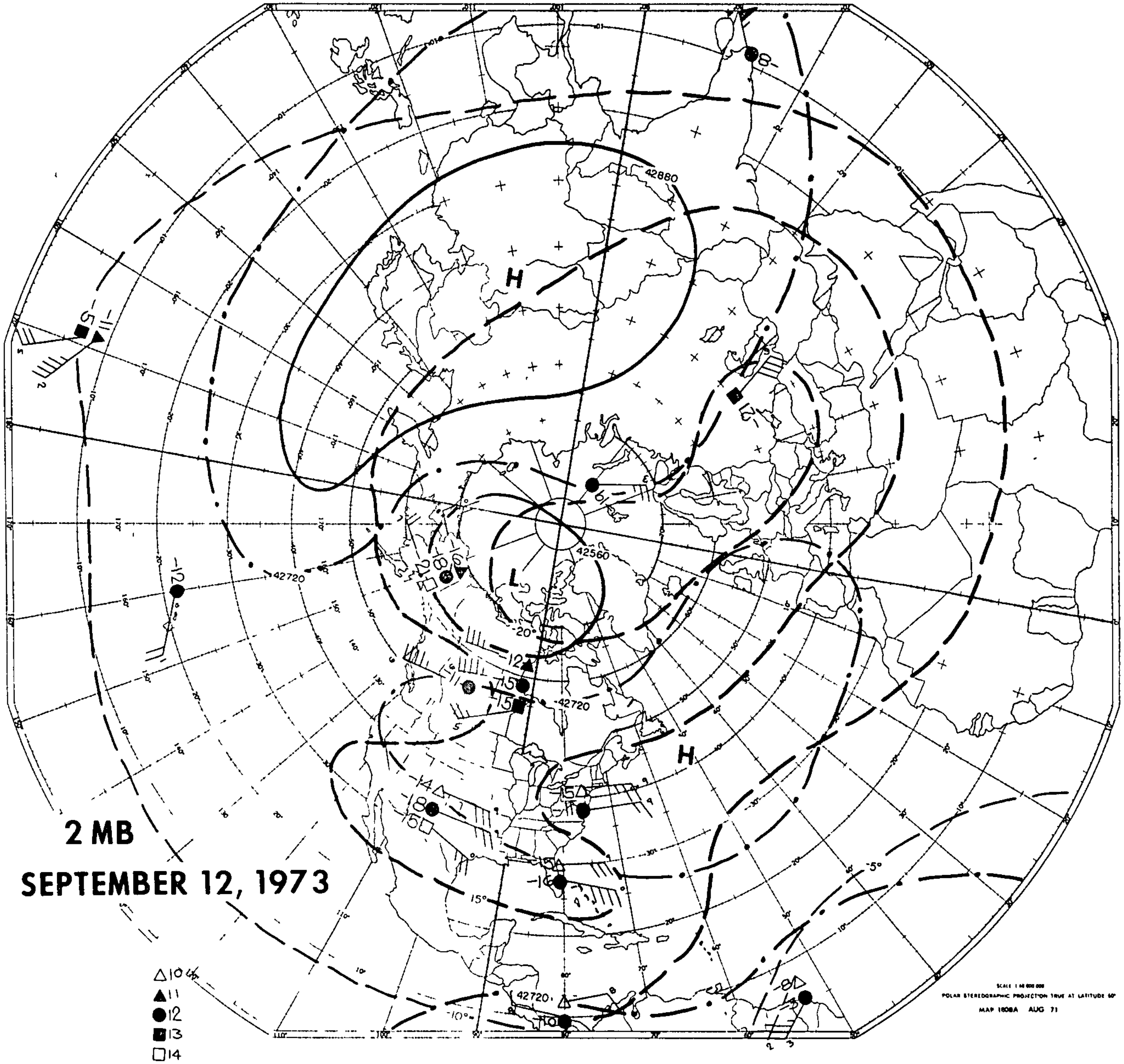
MAP 1608A AUG 71



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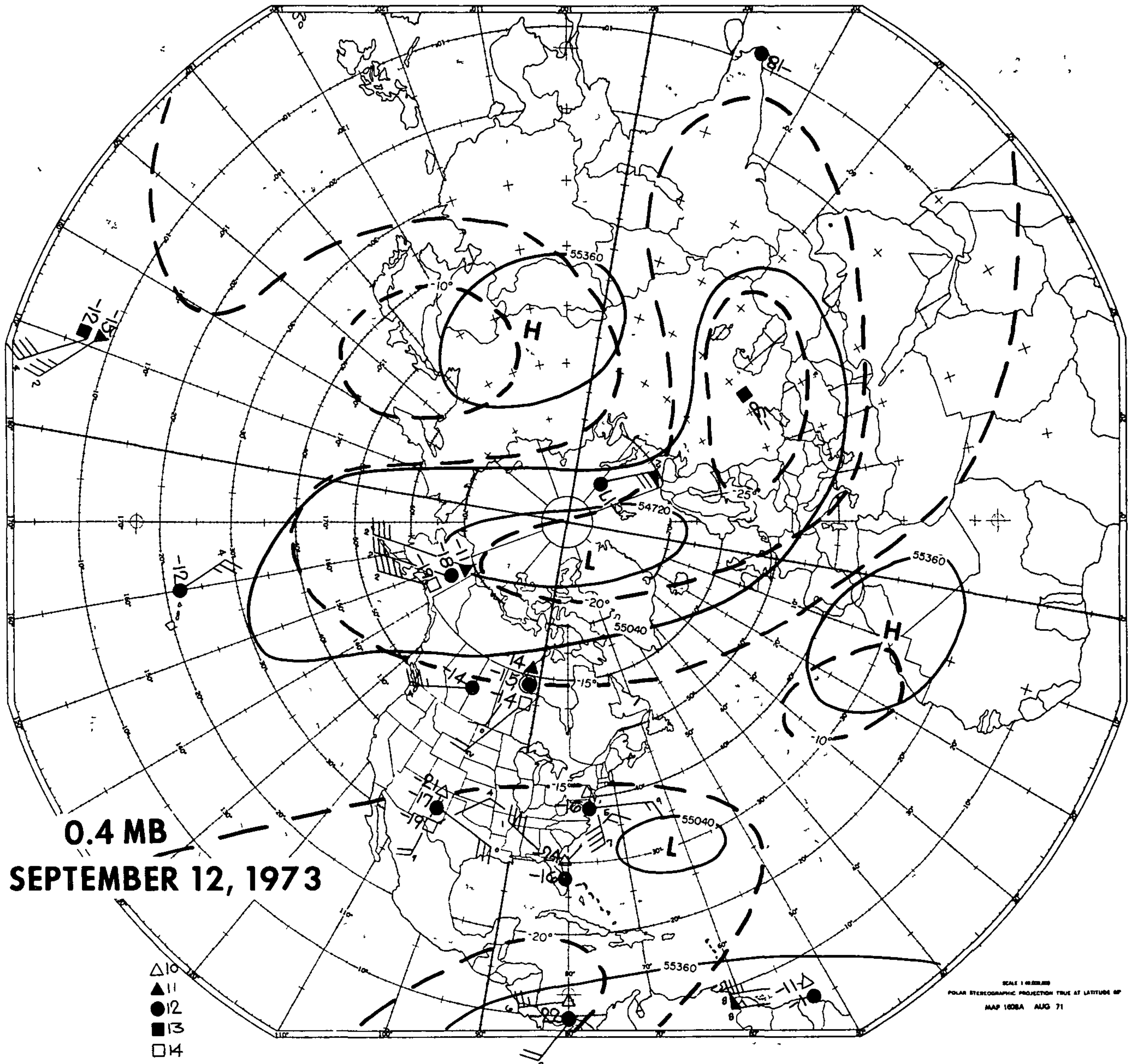

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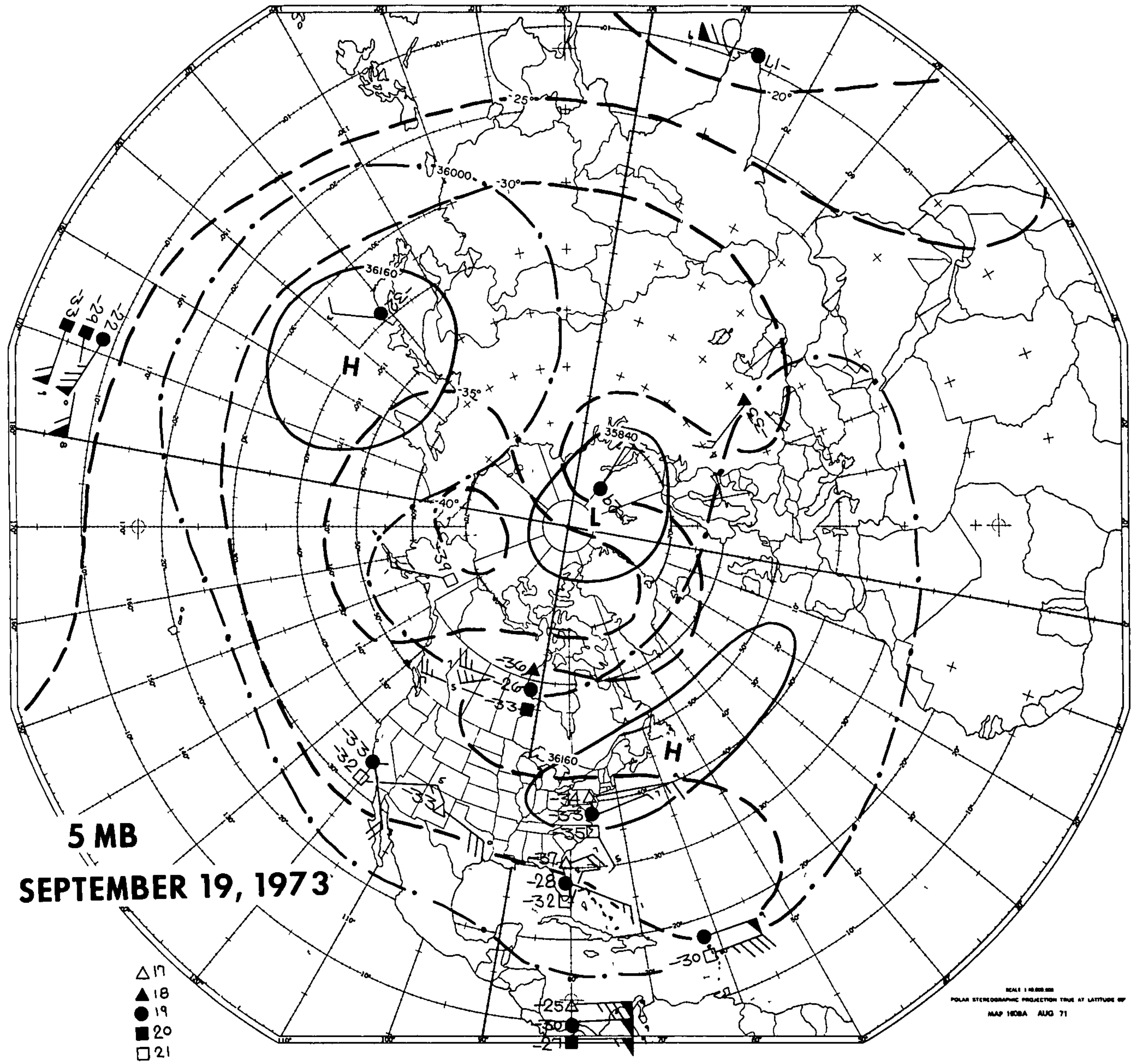

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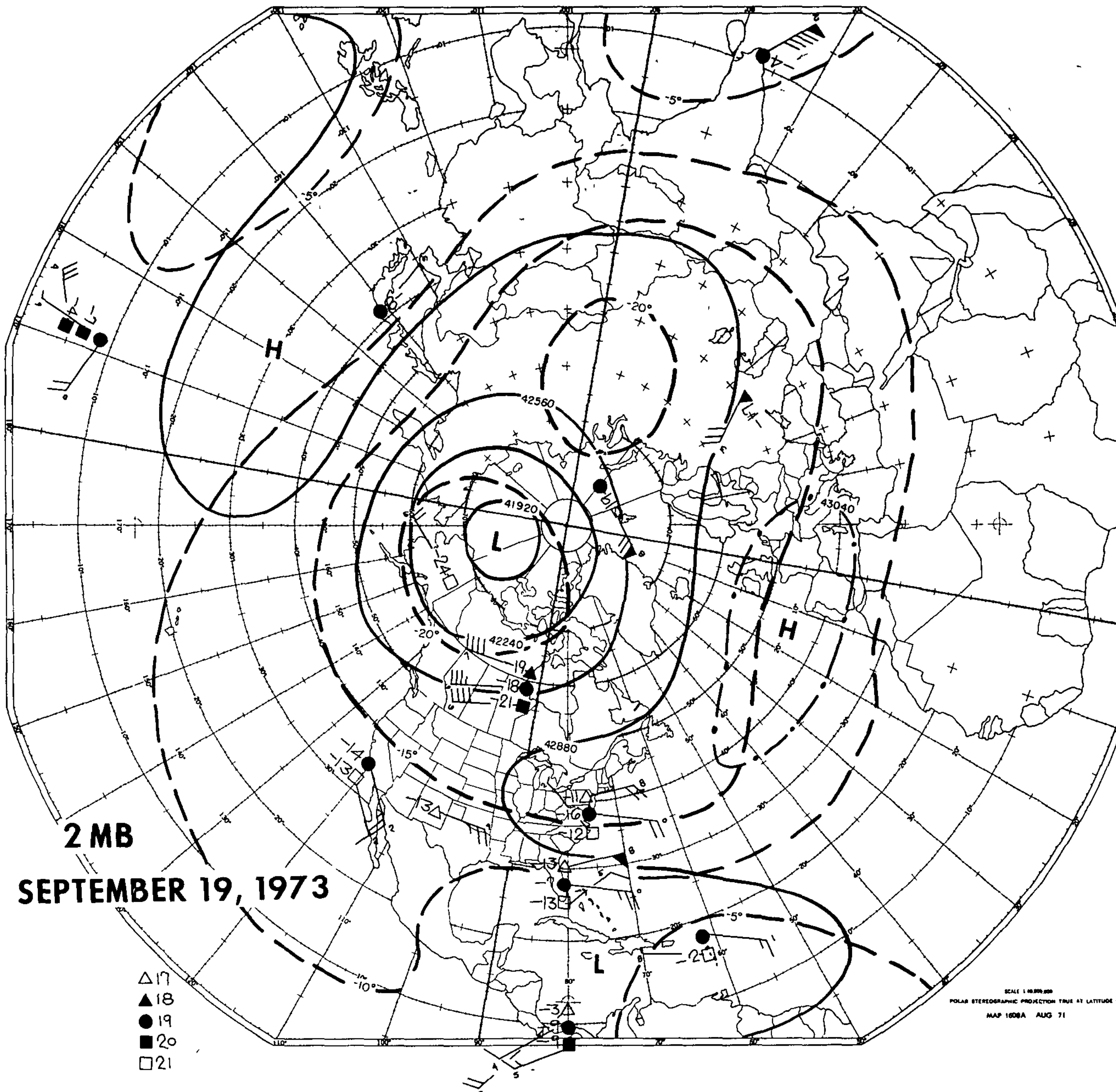

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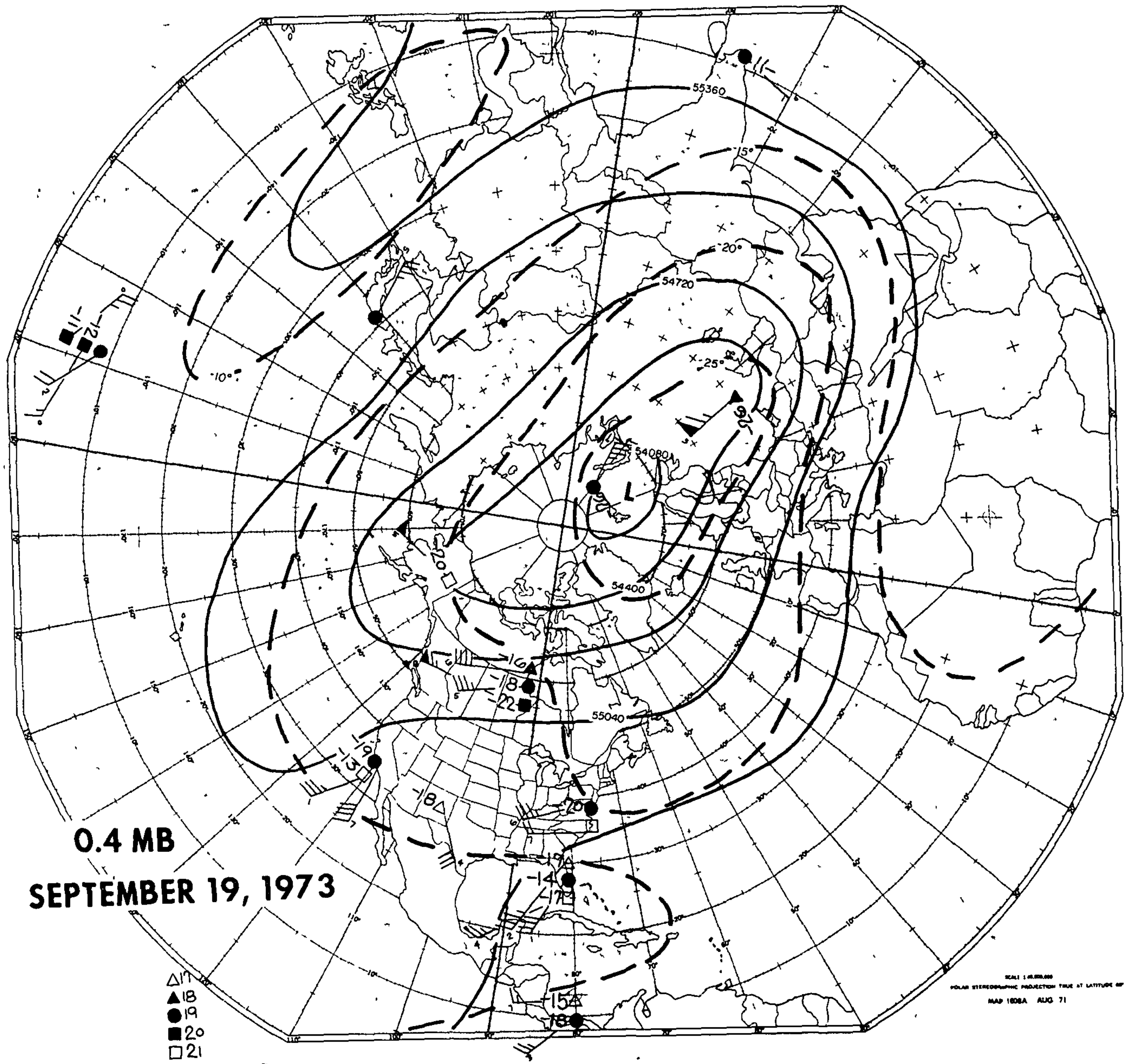

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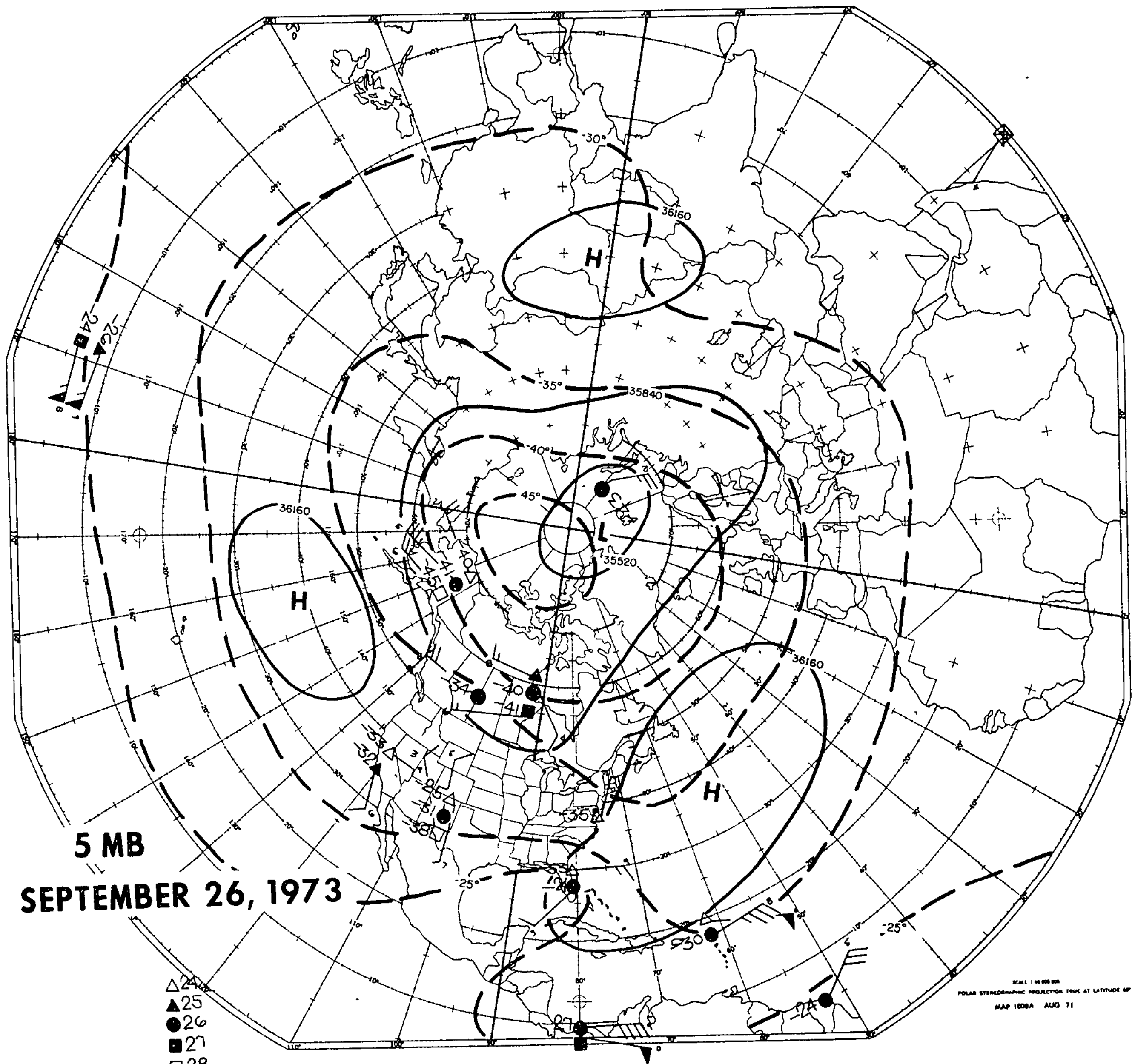

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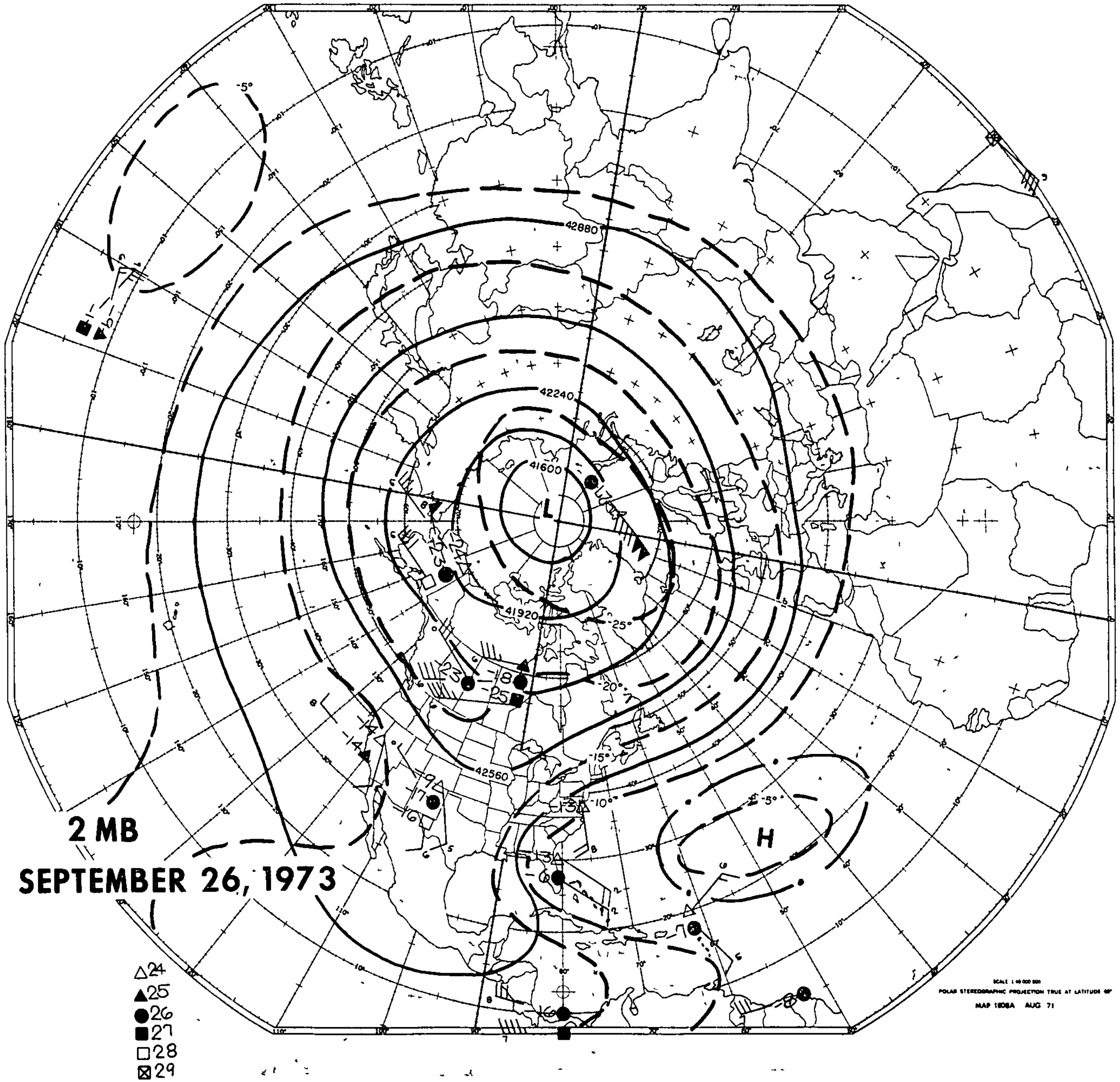

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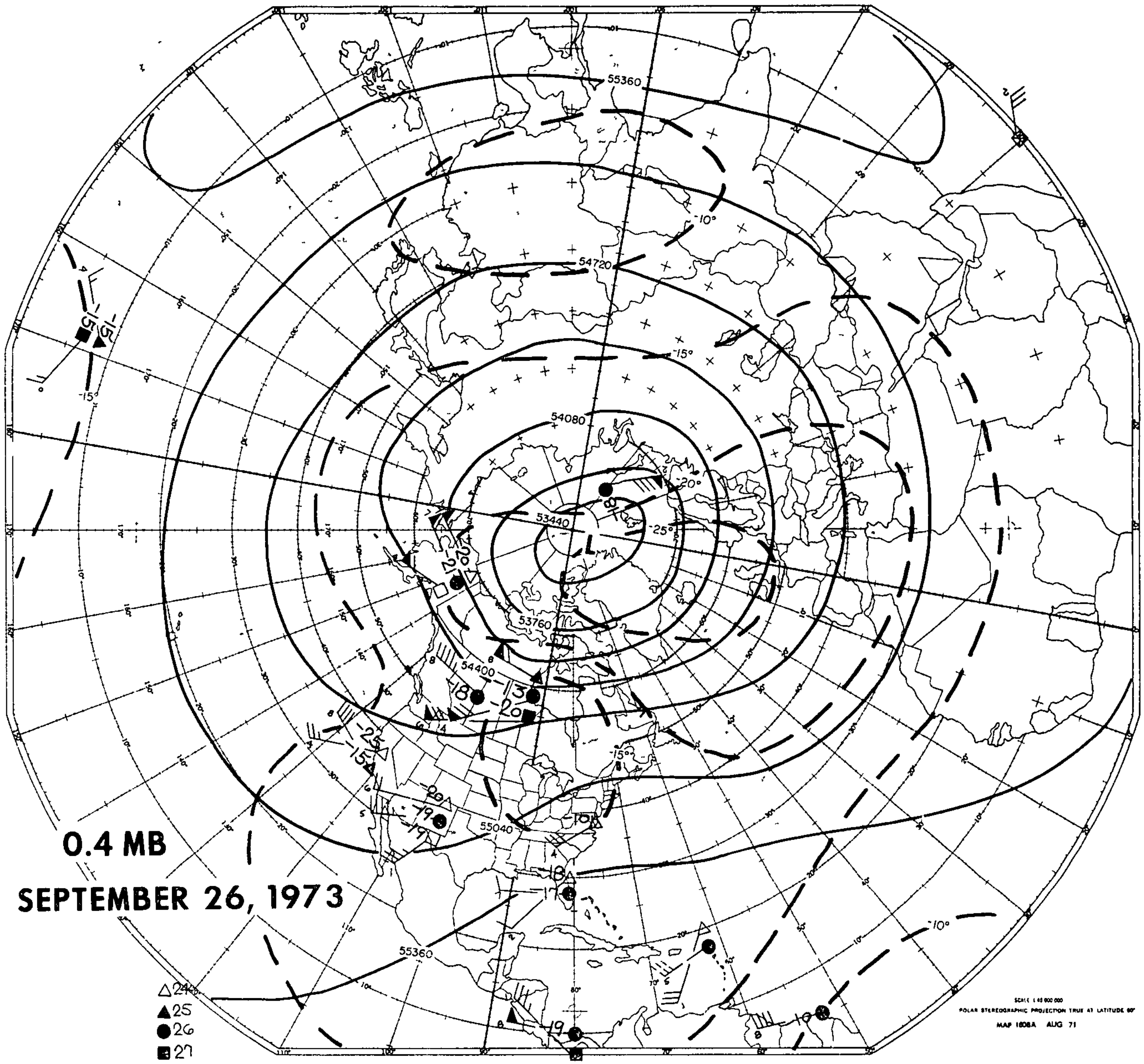

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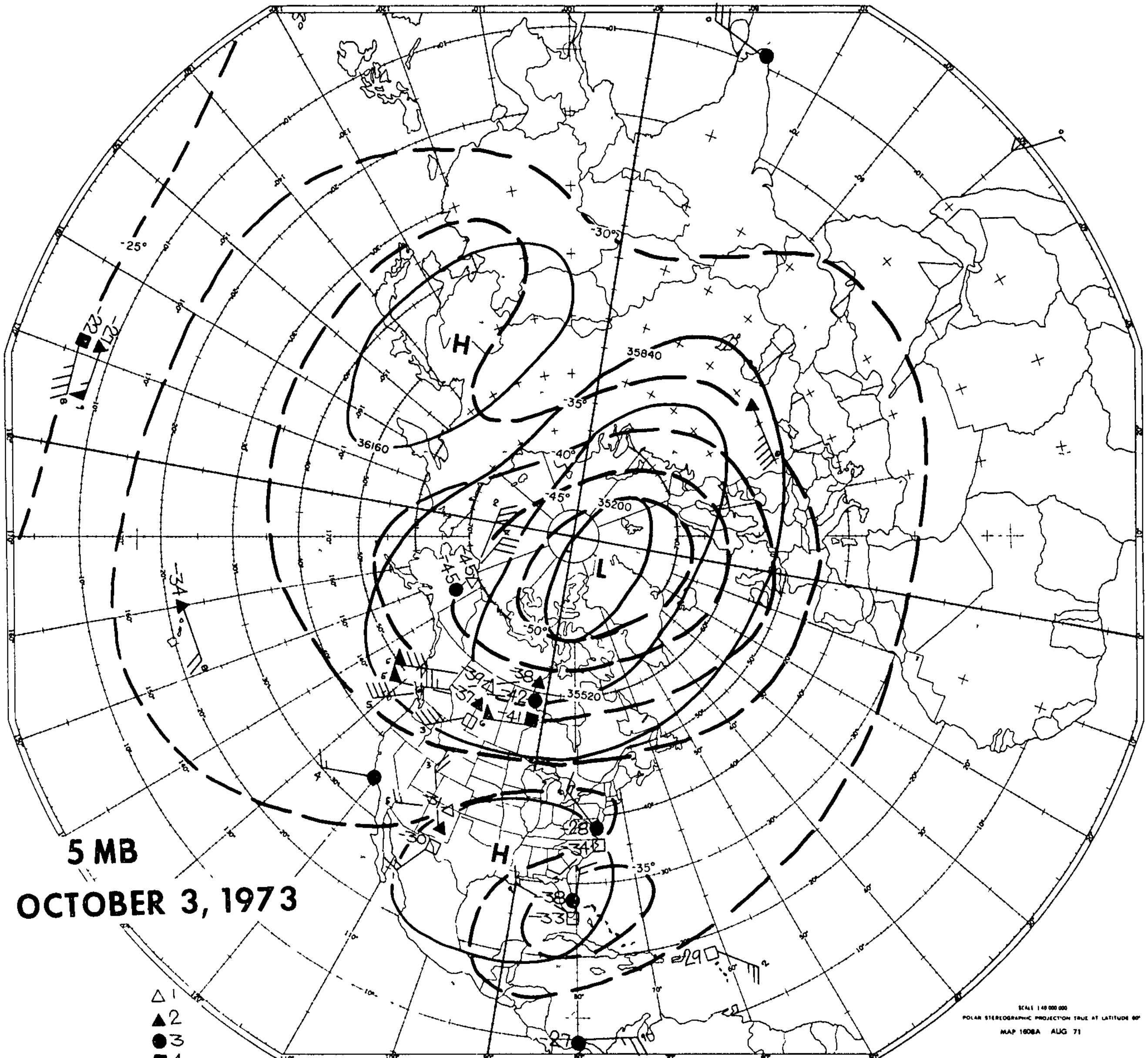

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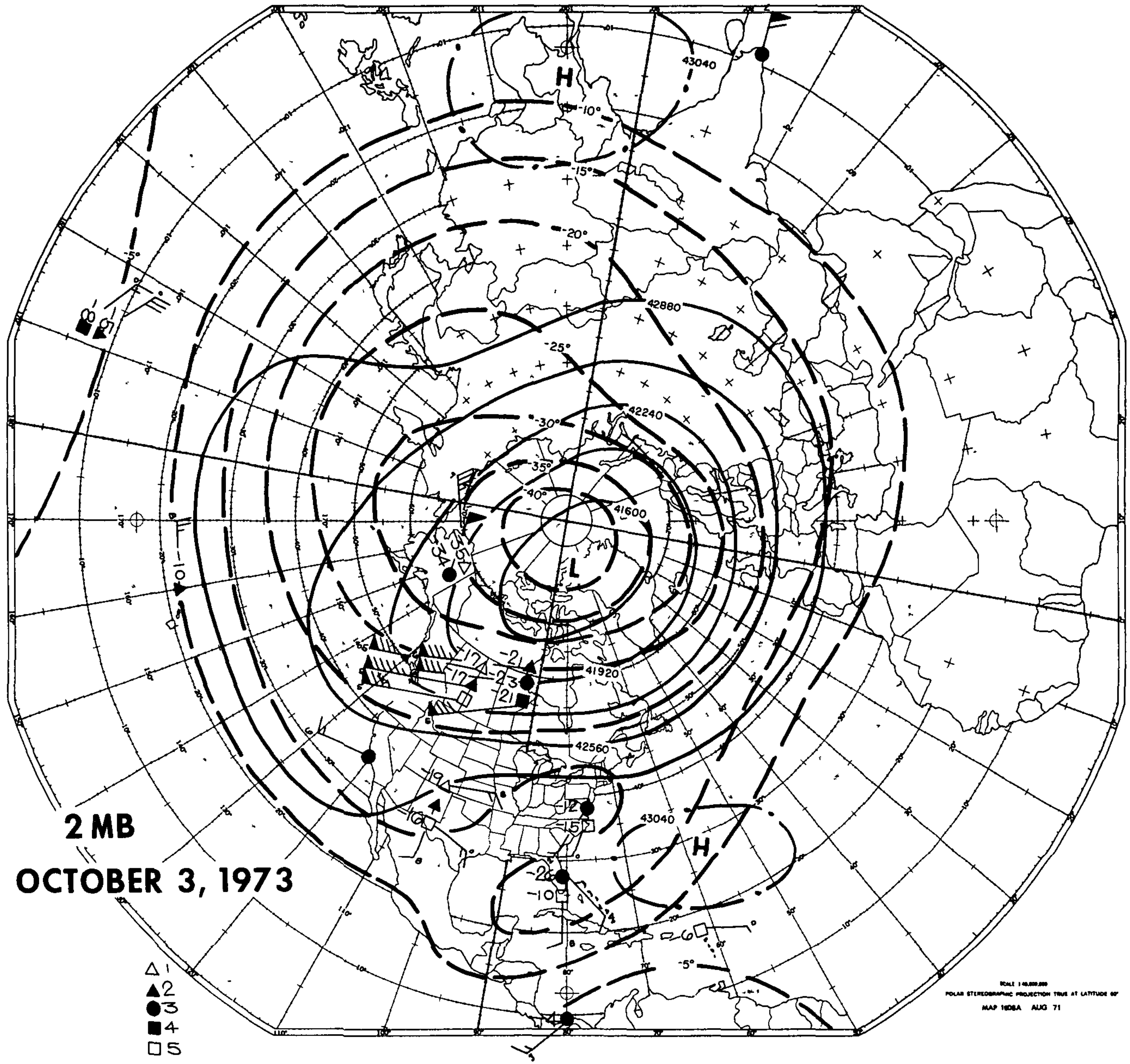

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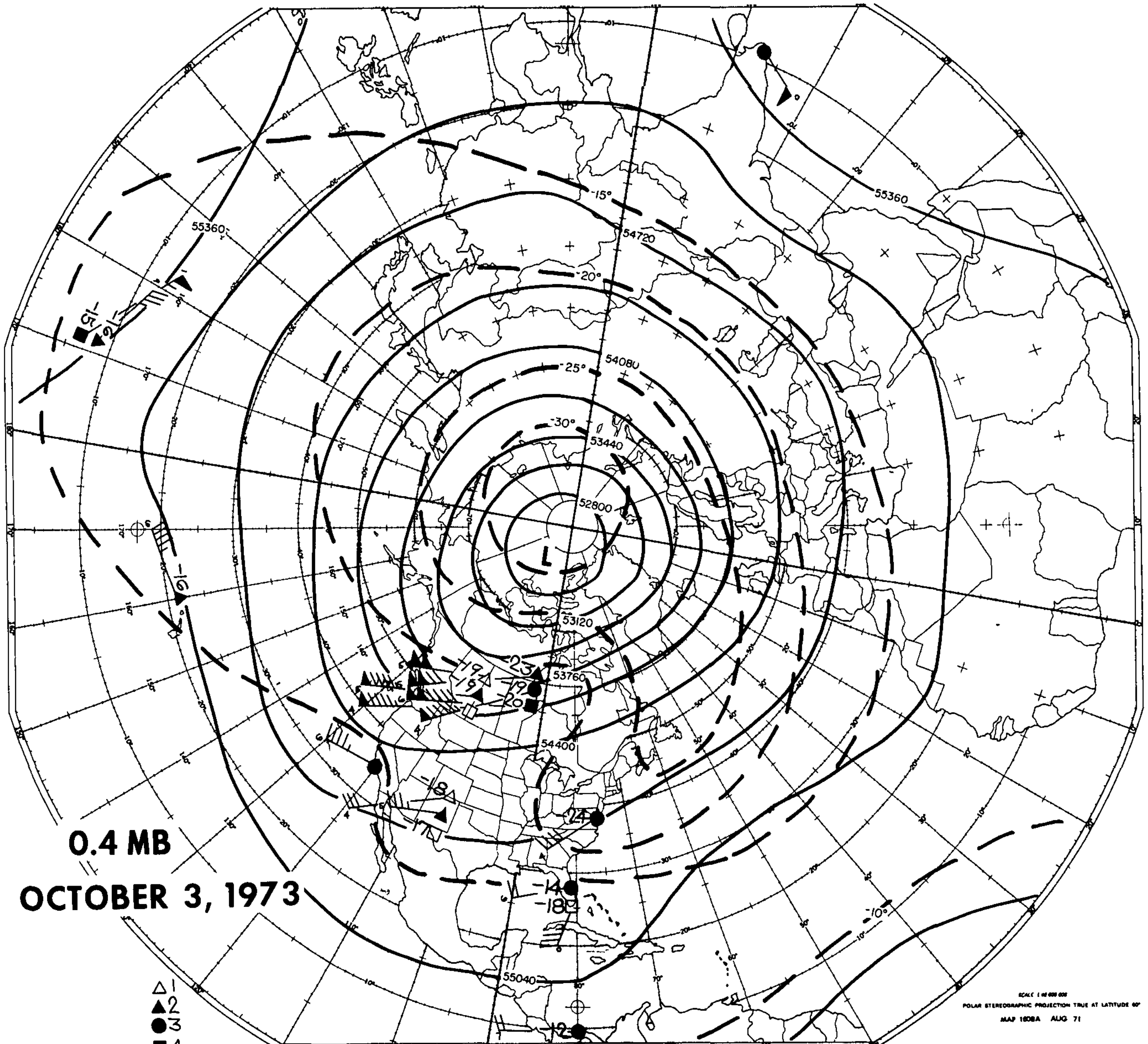

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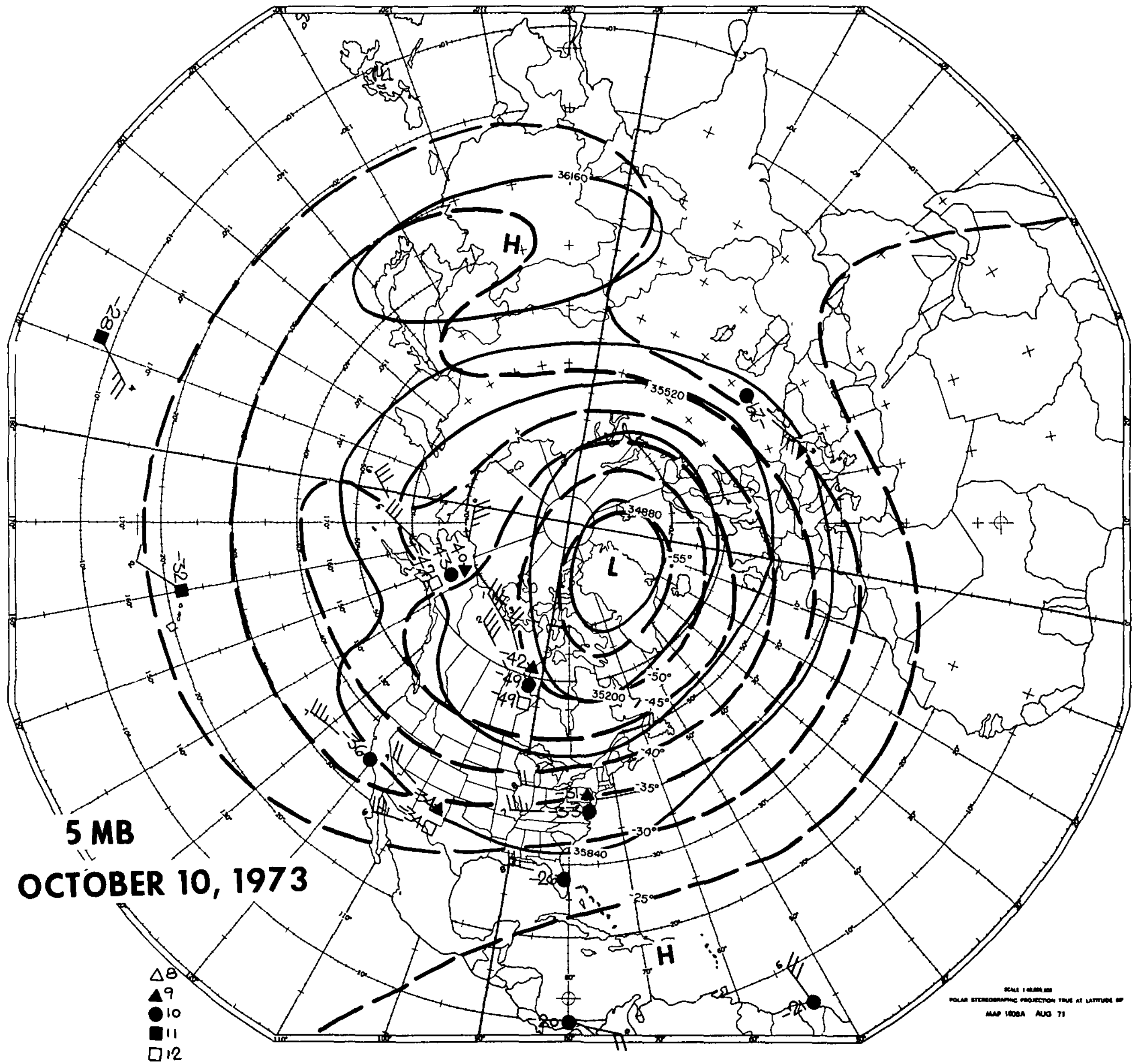

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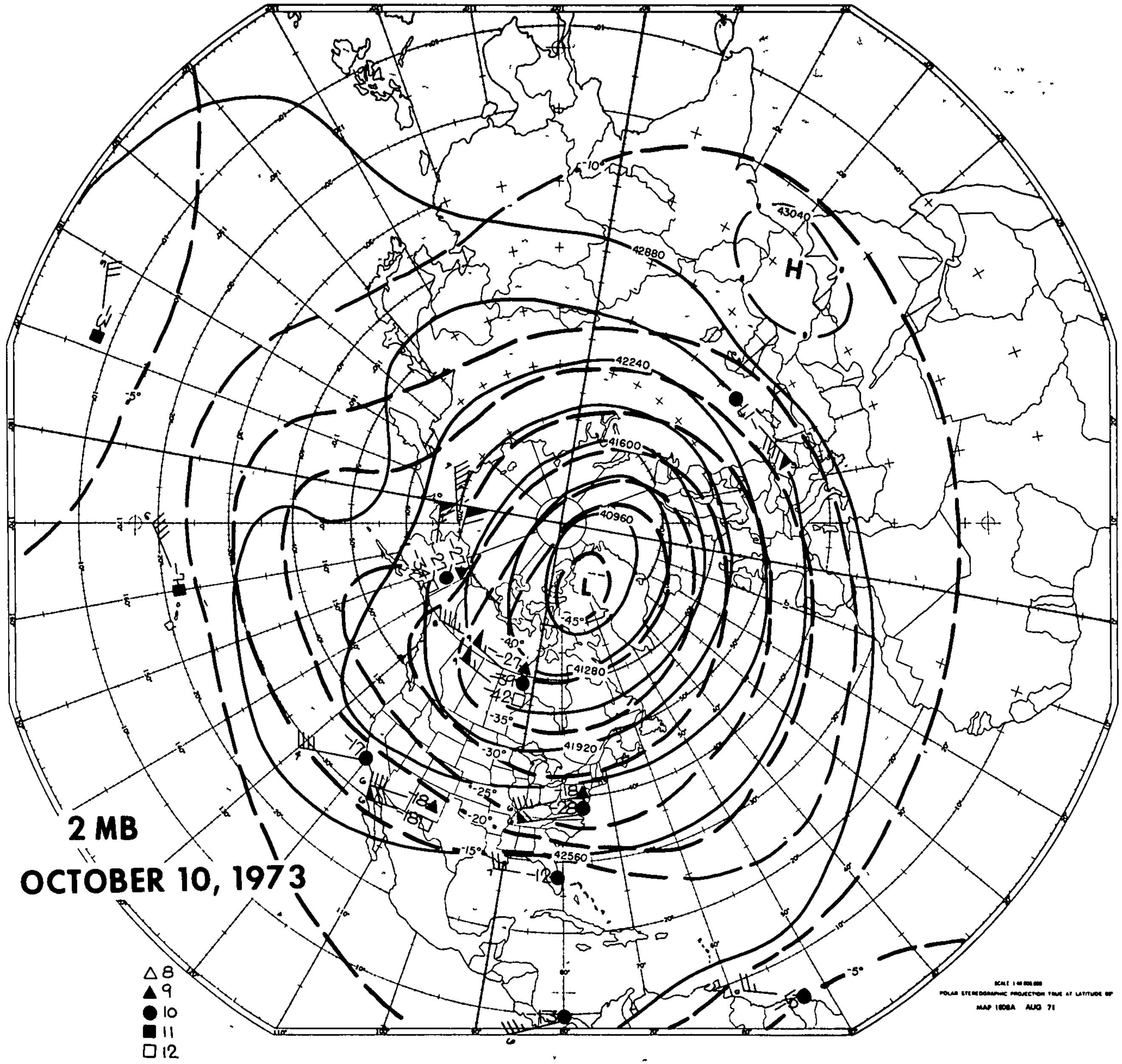

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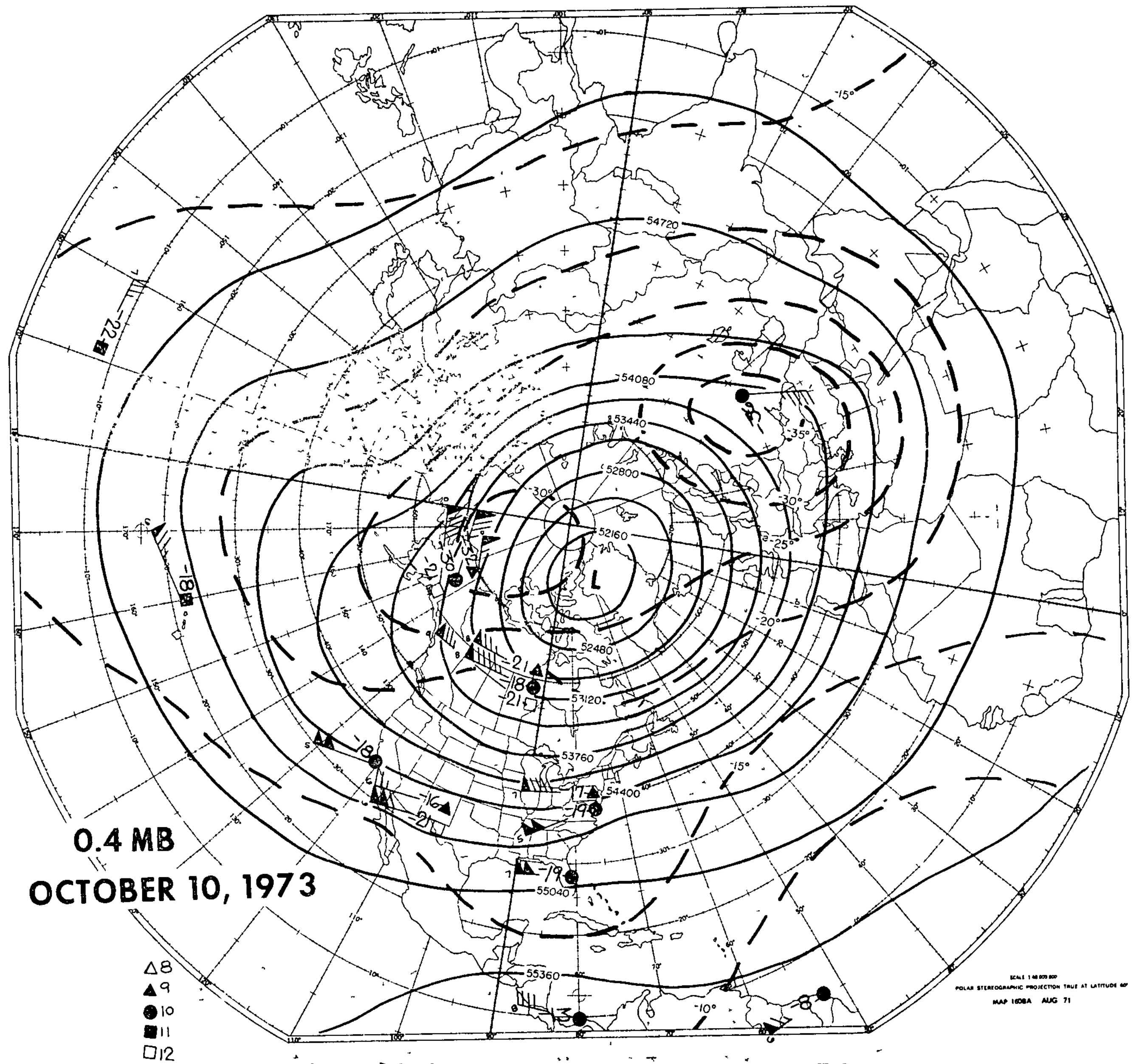

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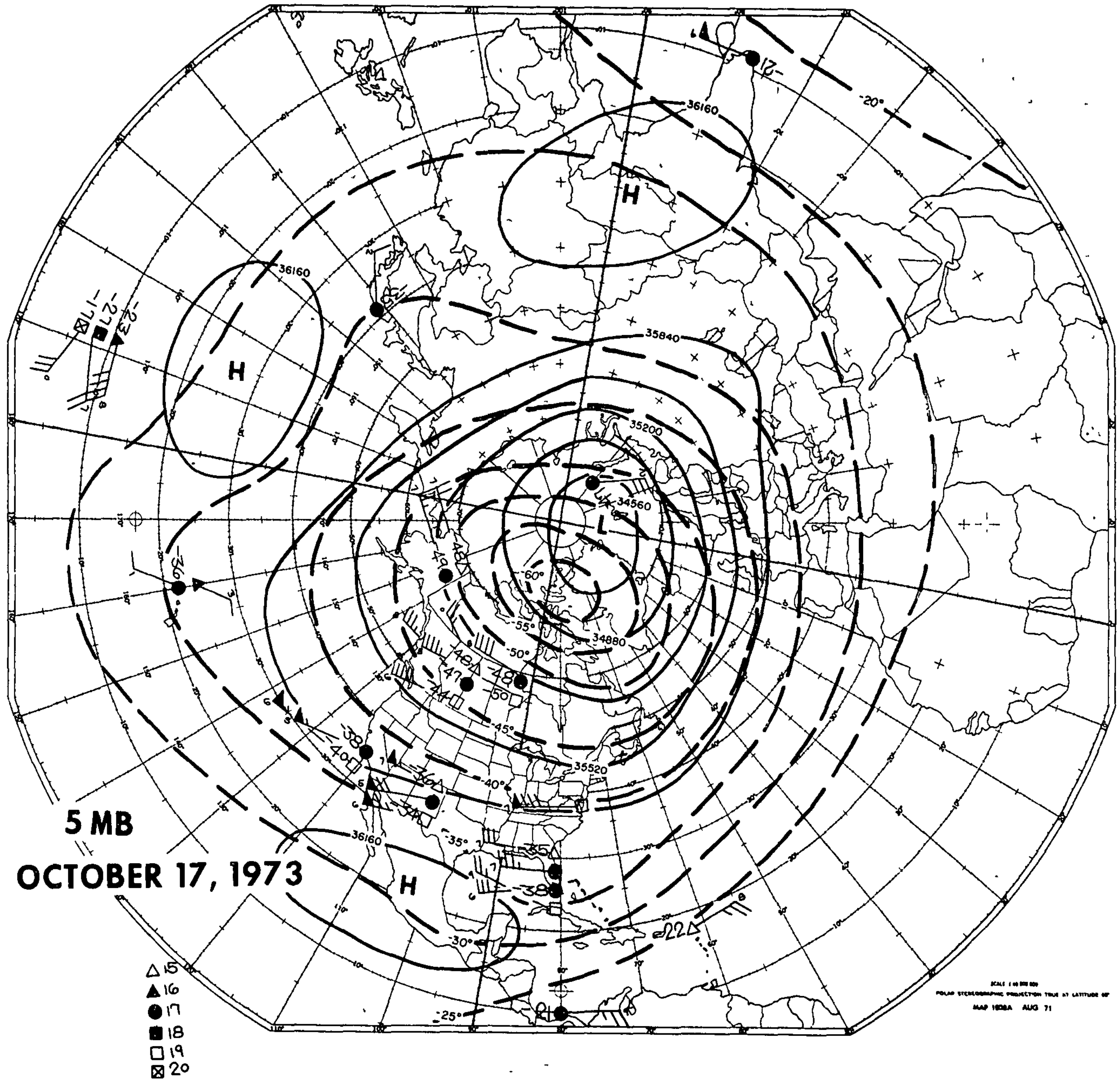
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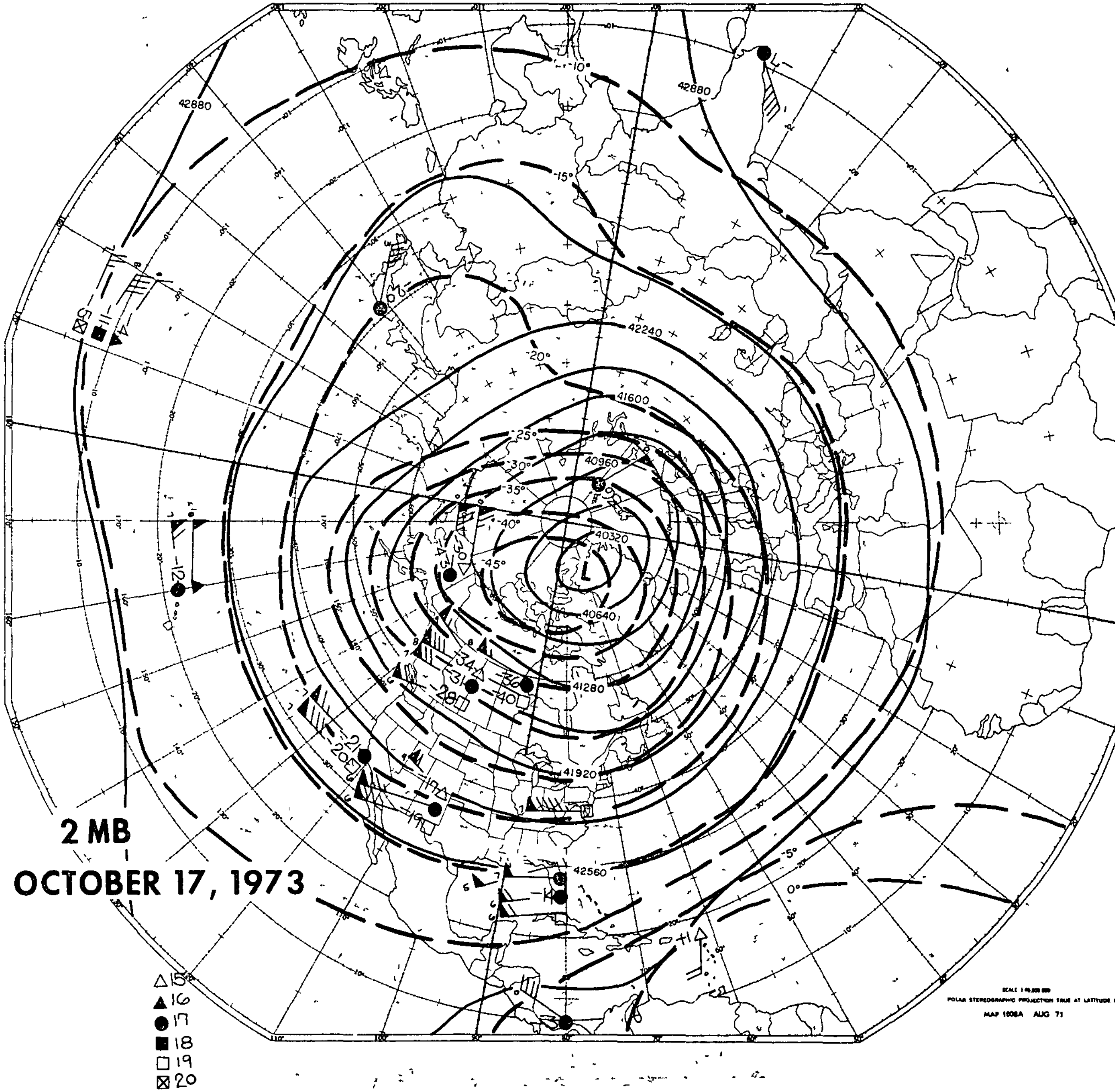

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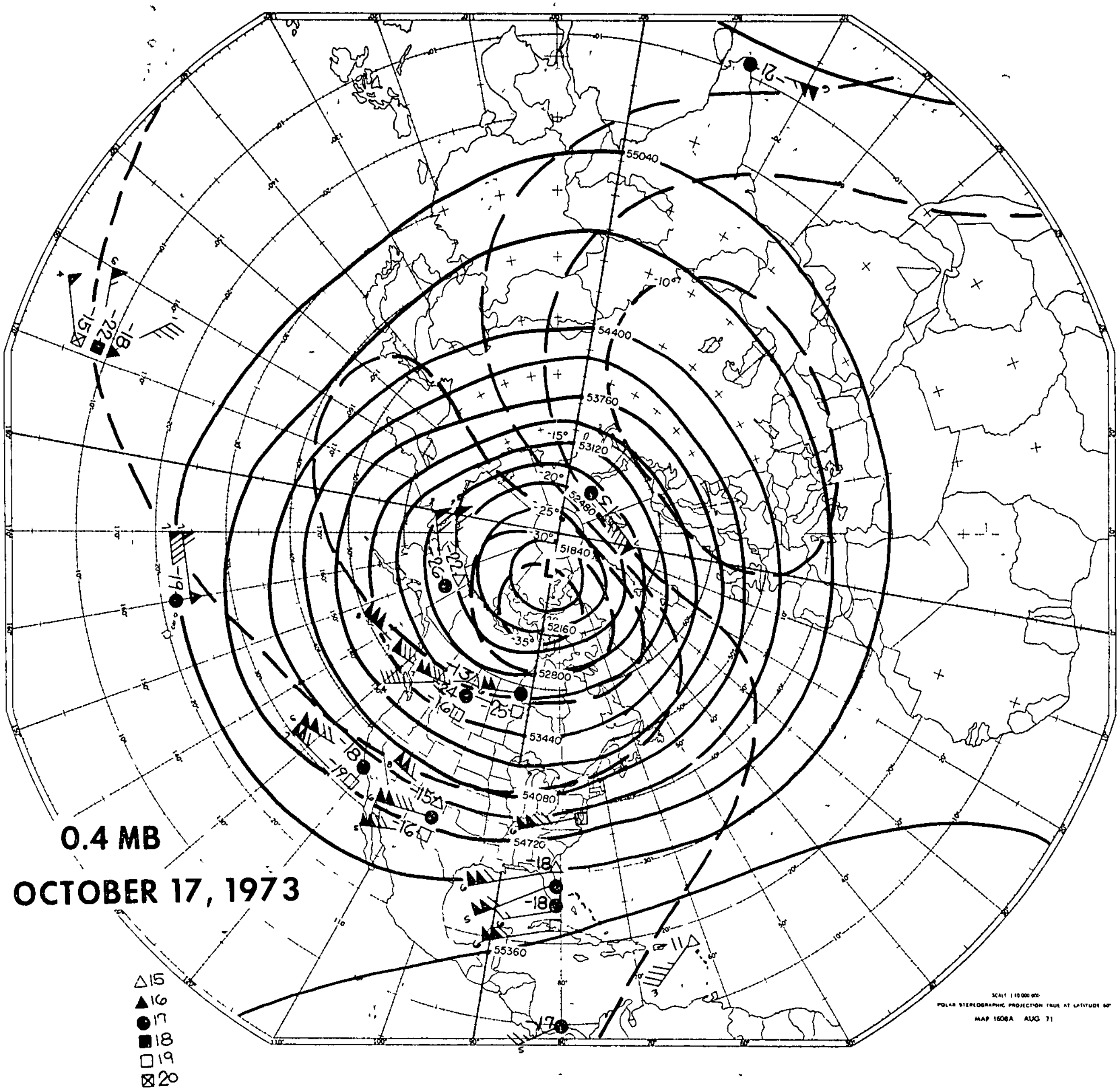
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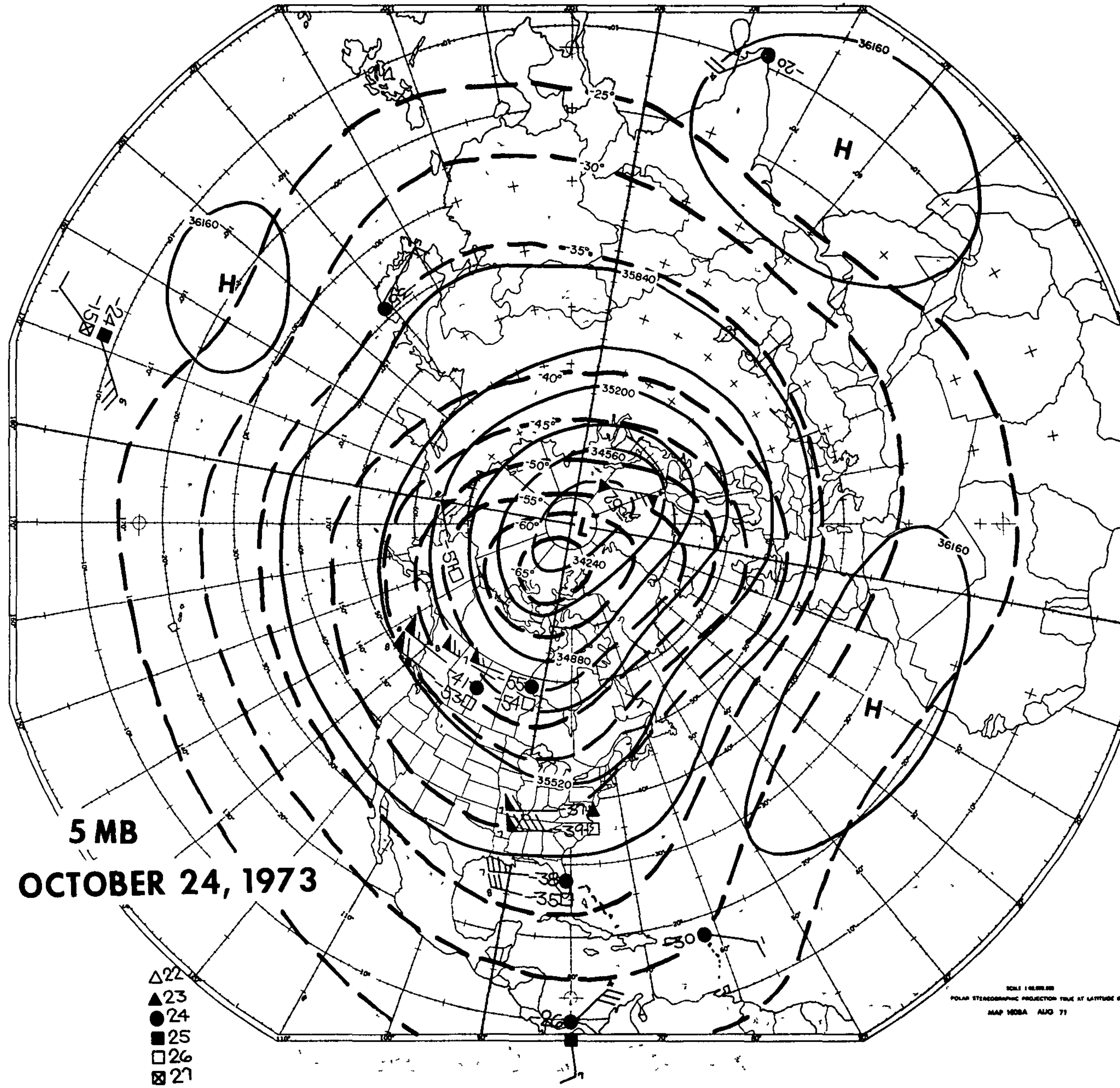
MAP 1606A AUG 71



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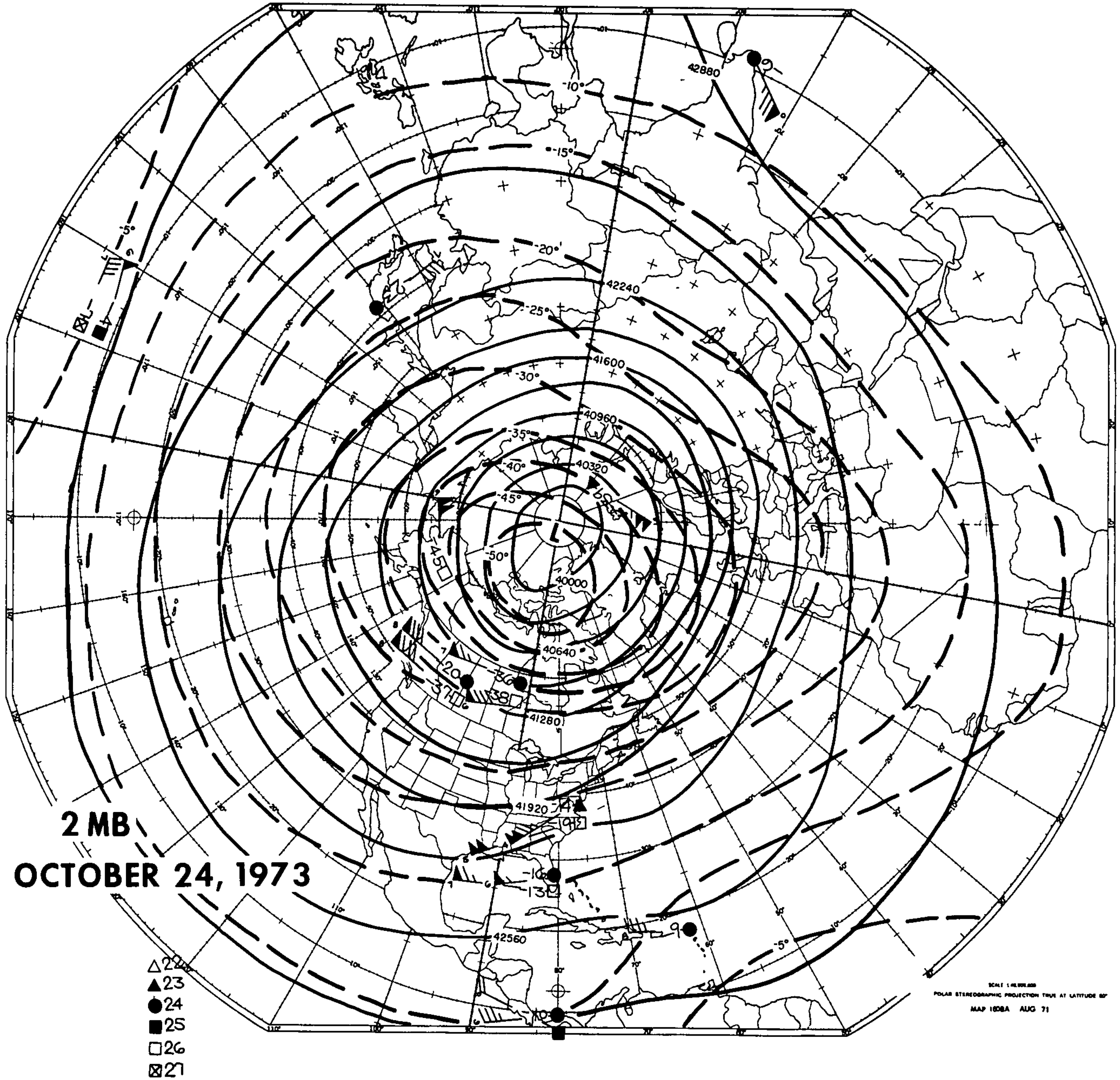

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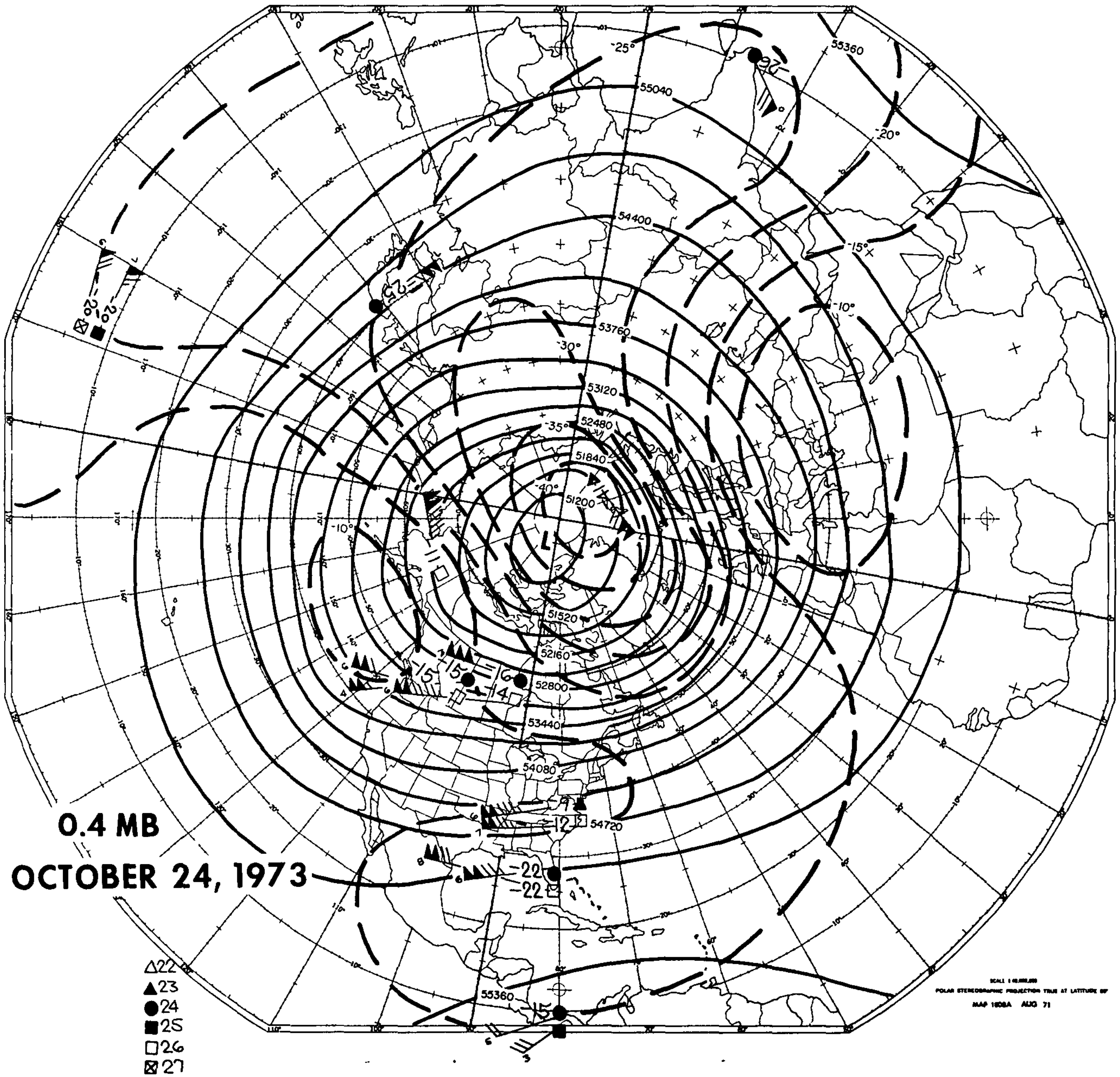

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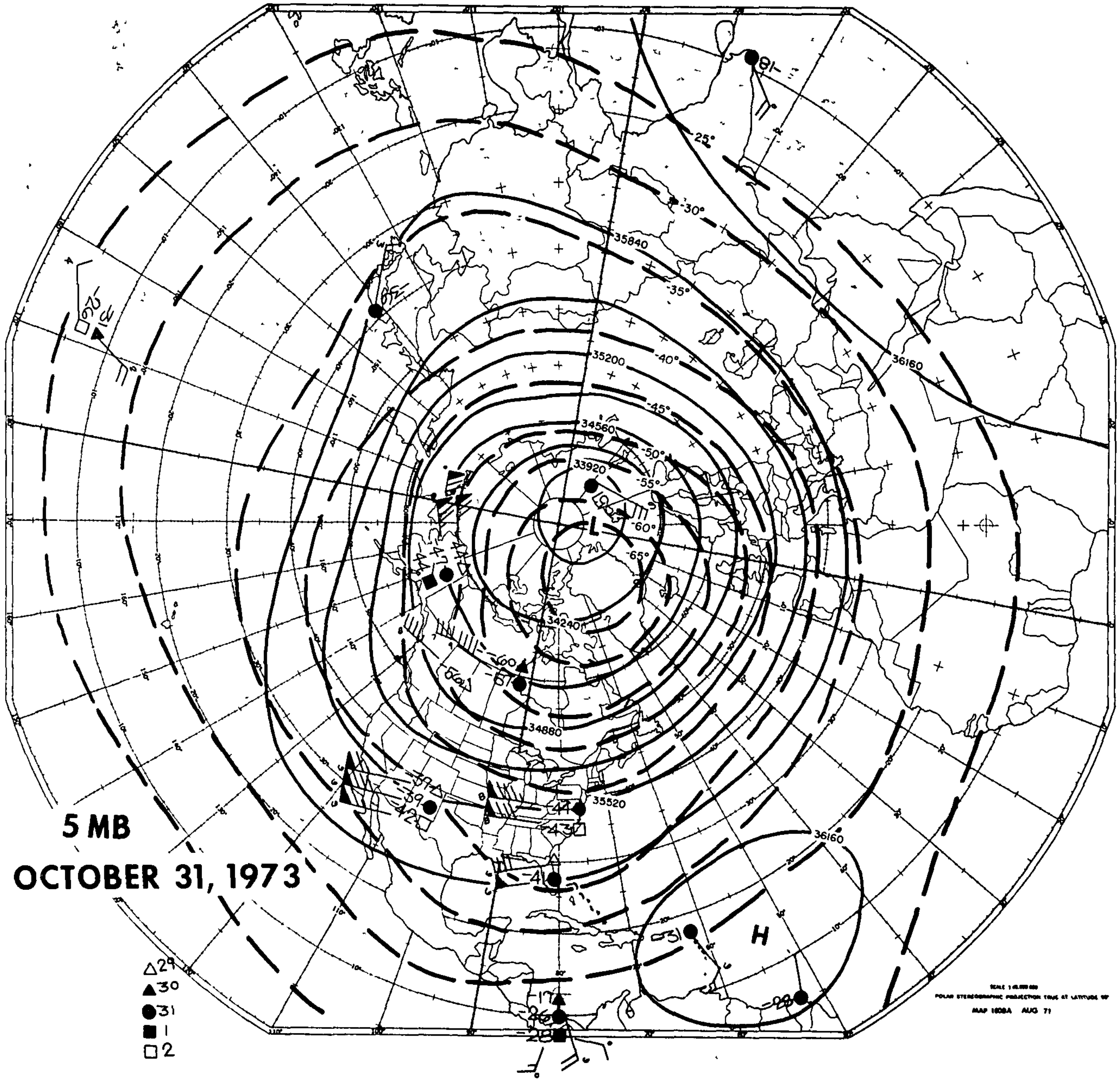

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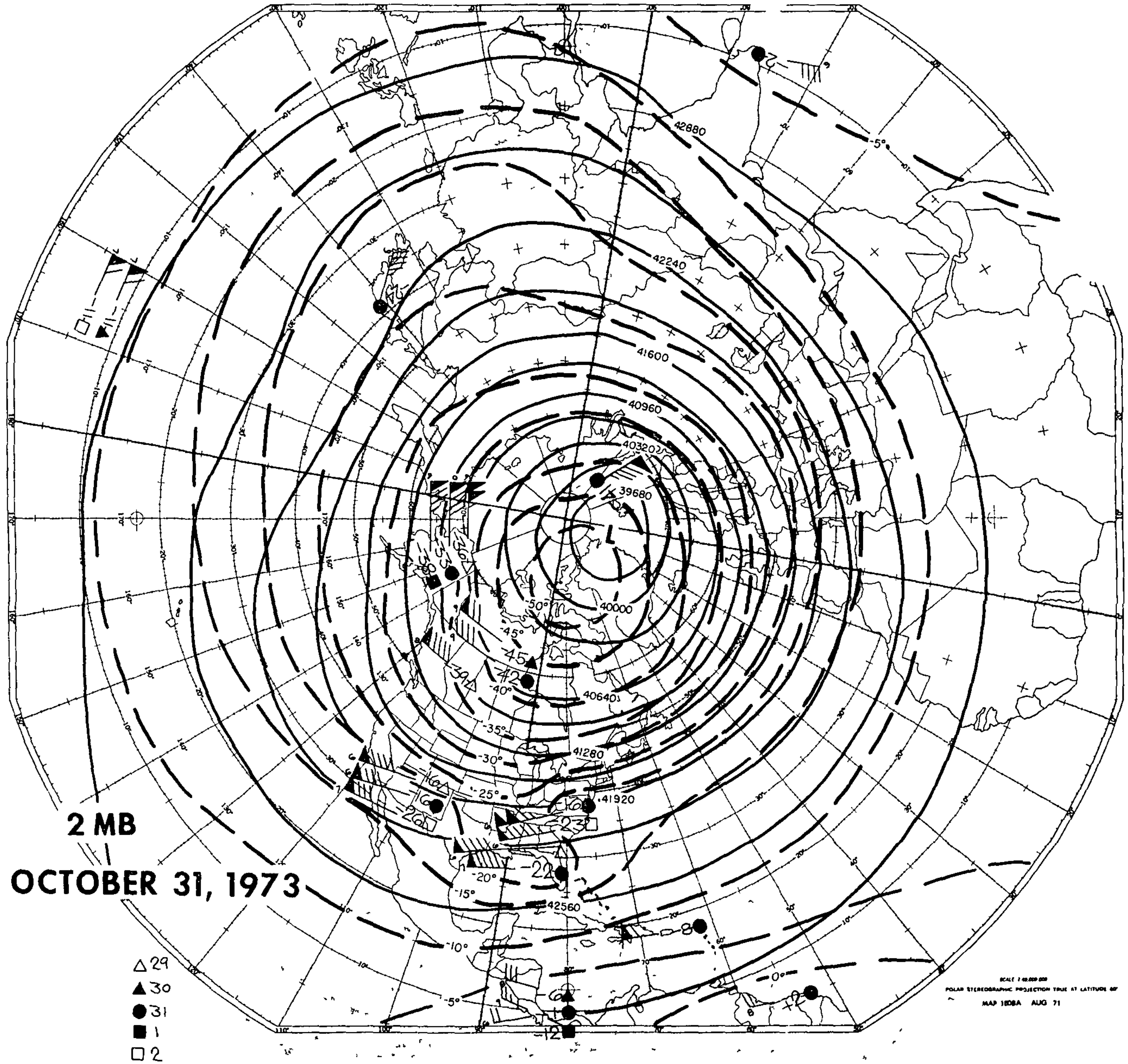

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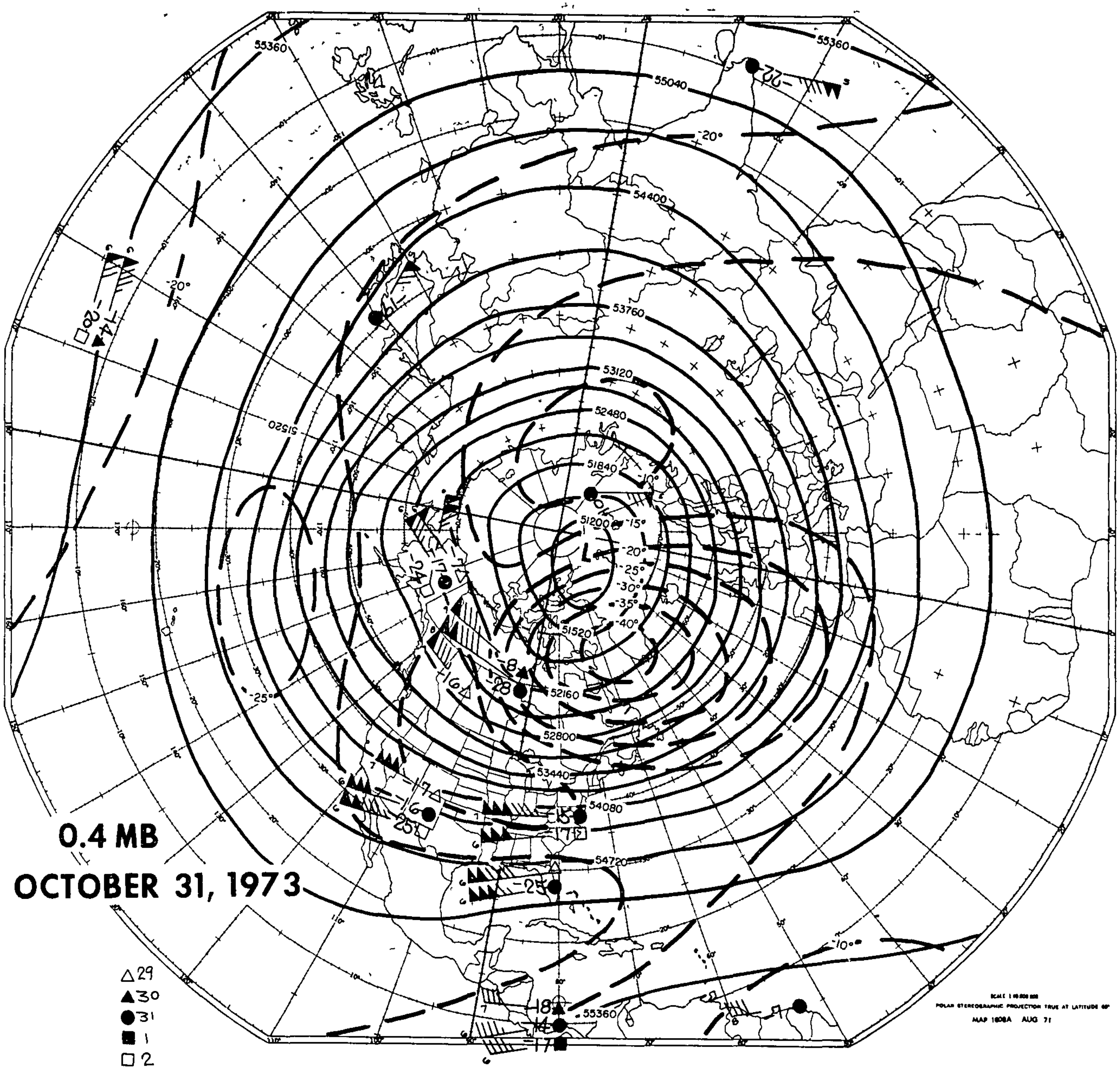

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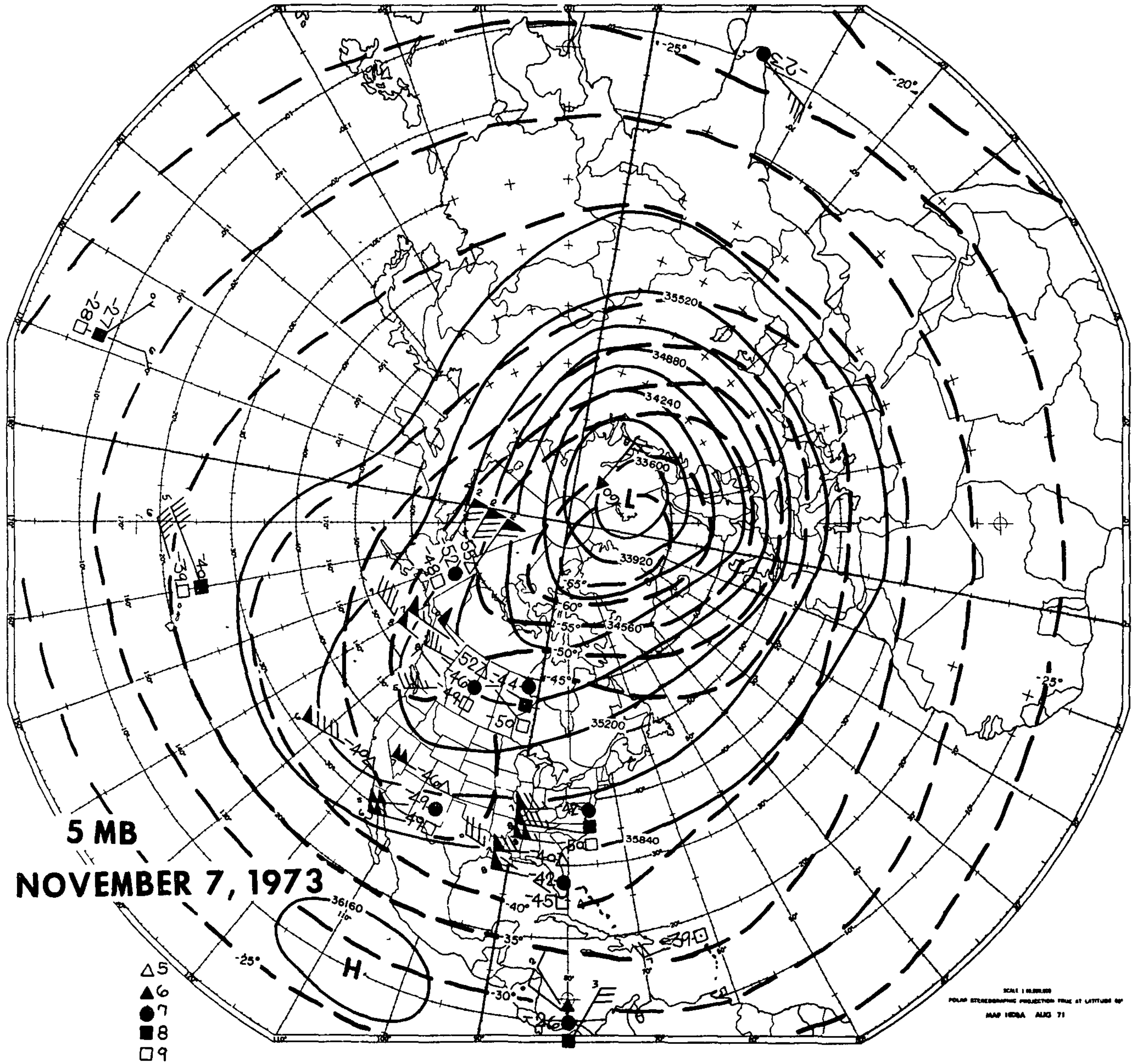

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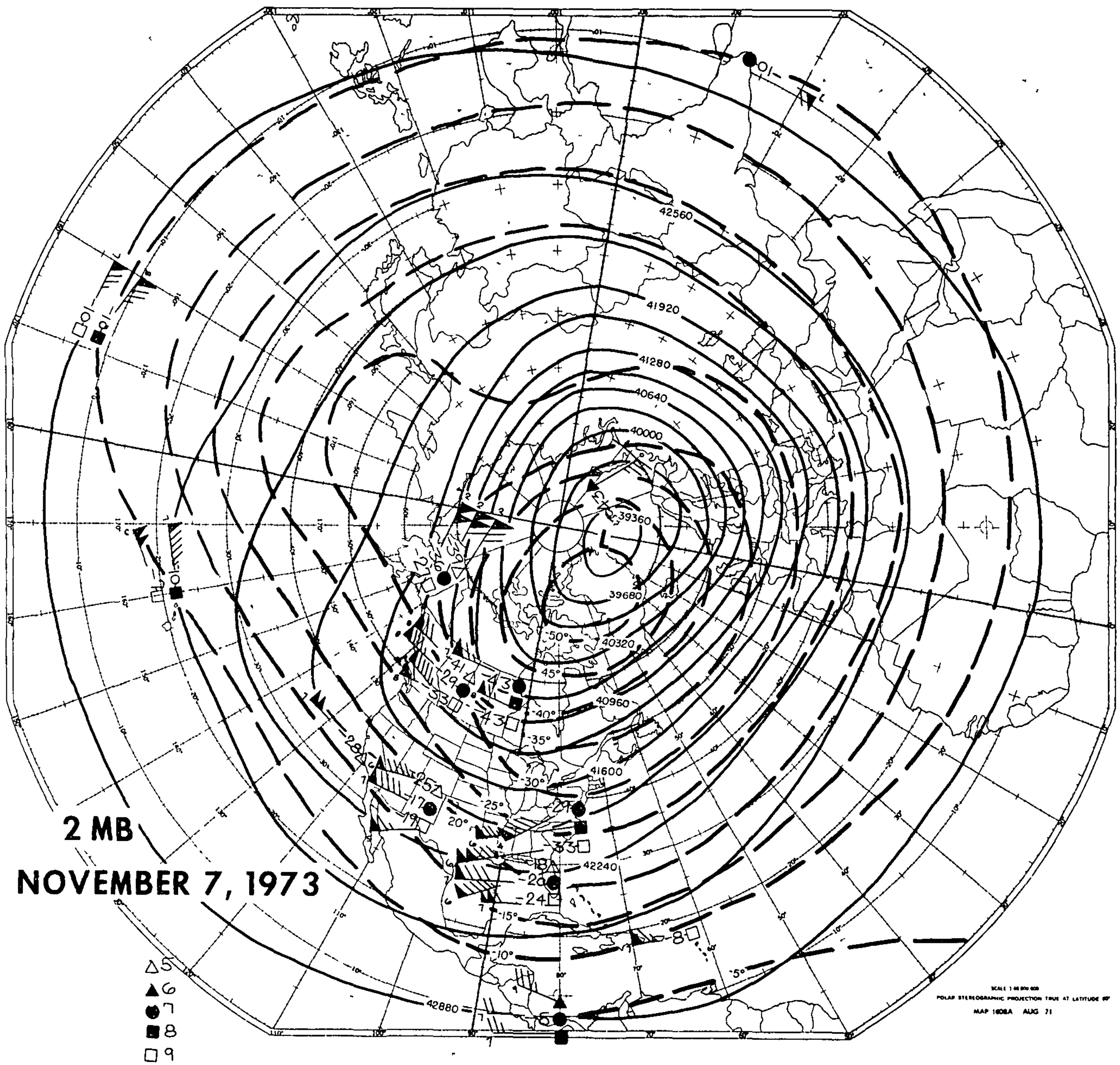

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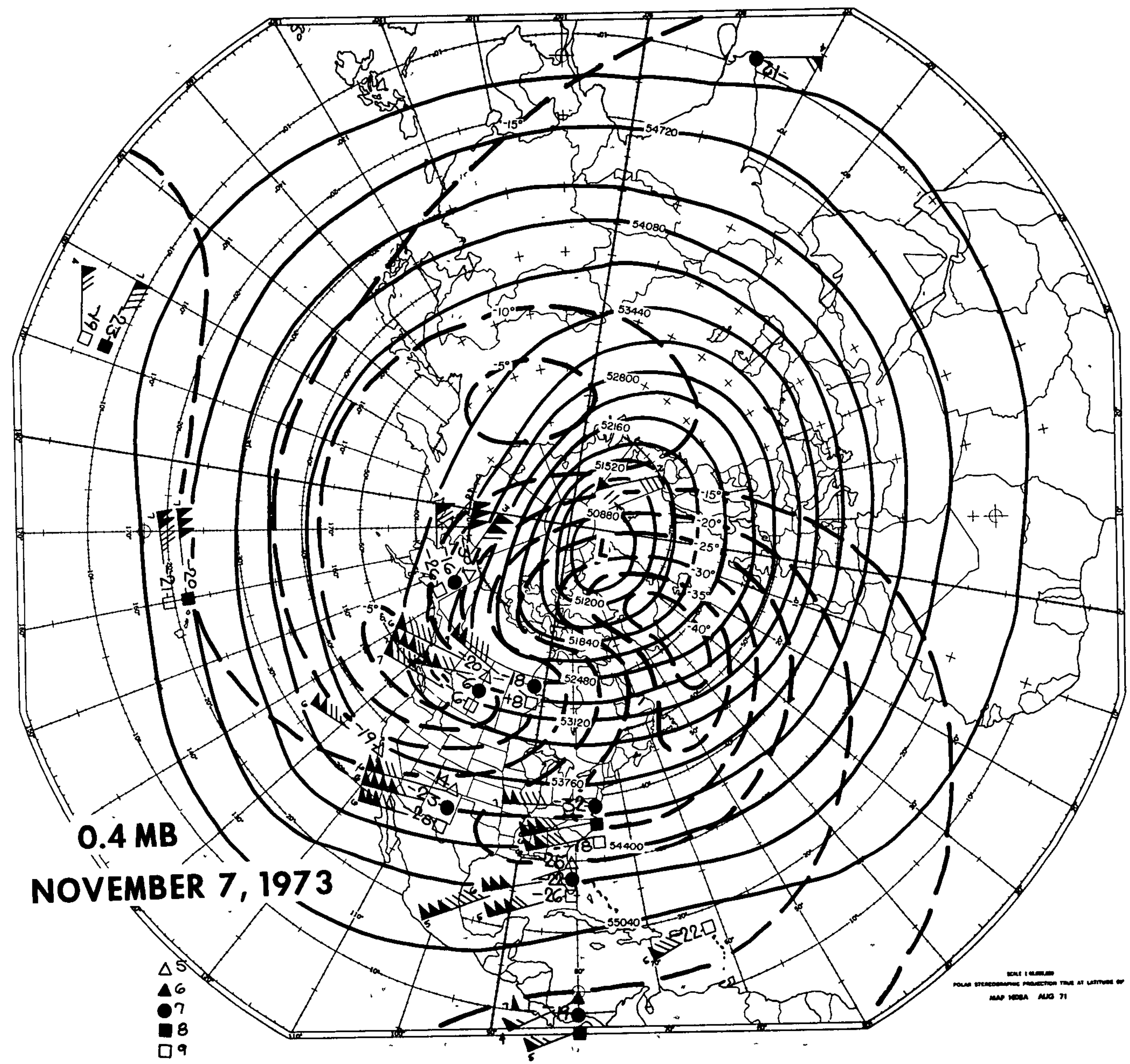

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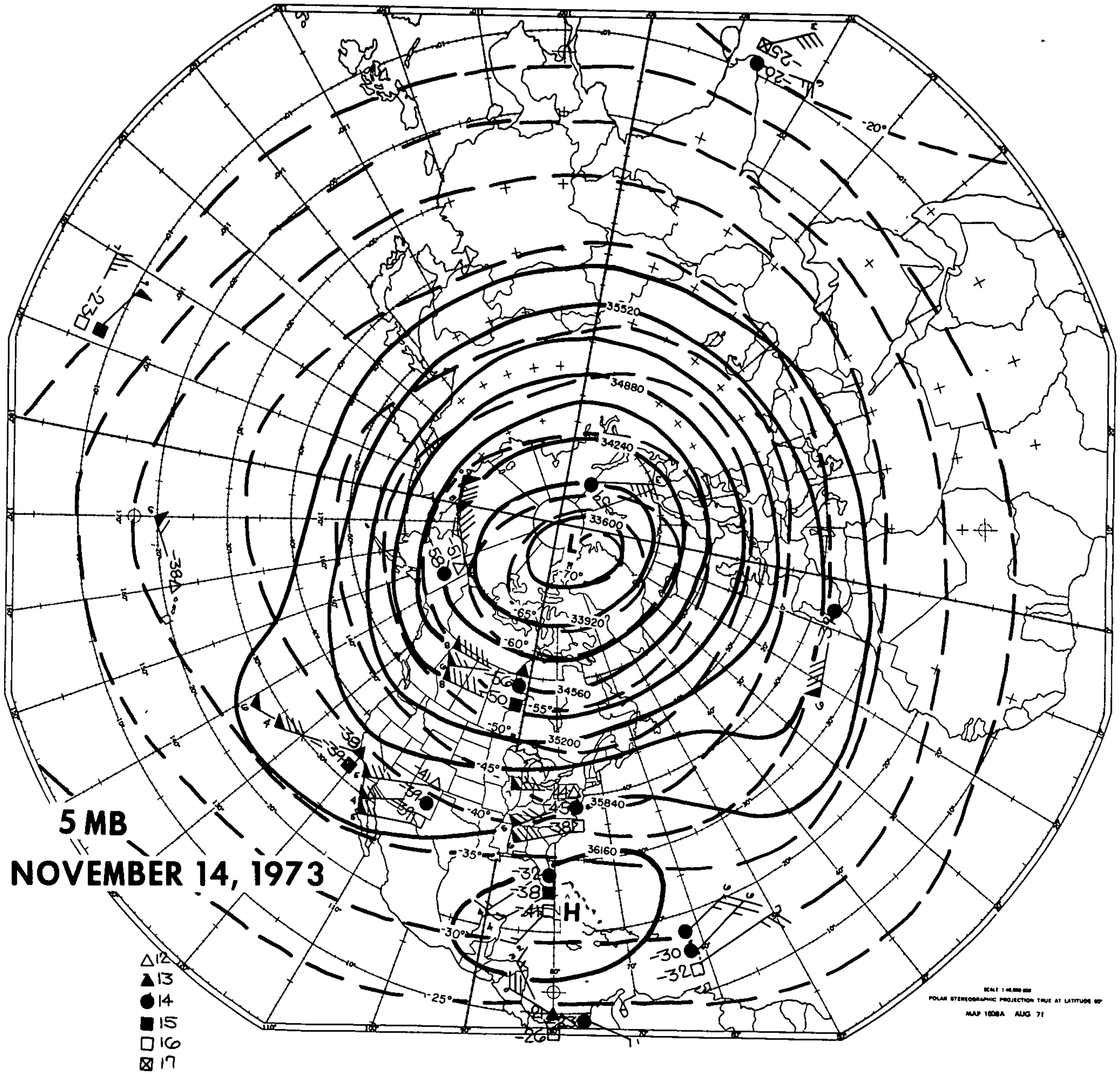

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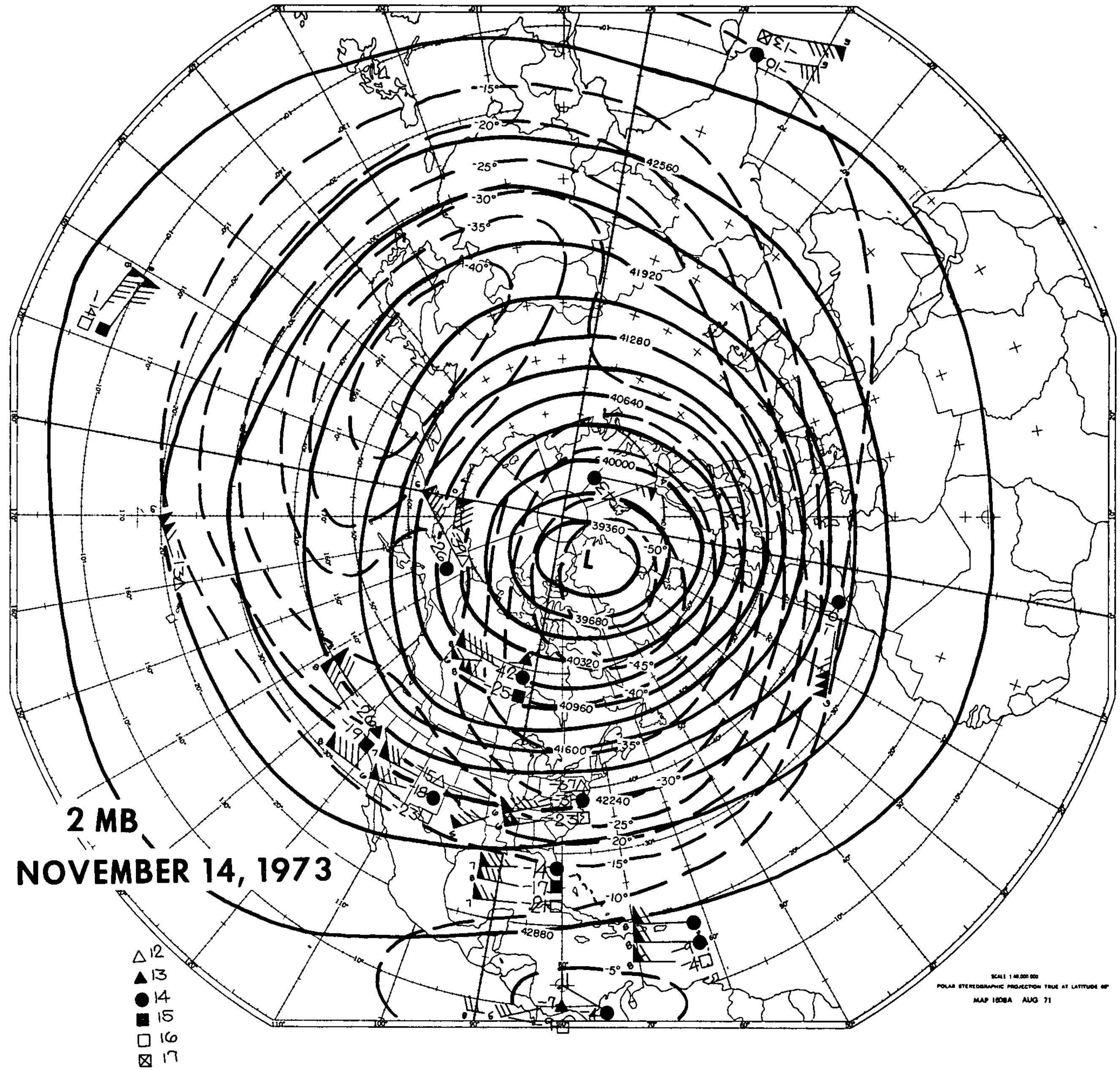
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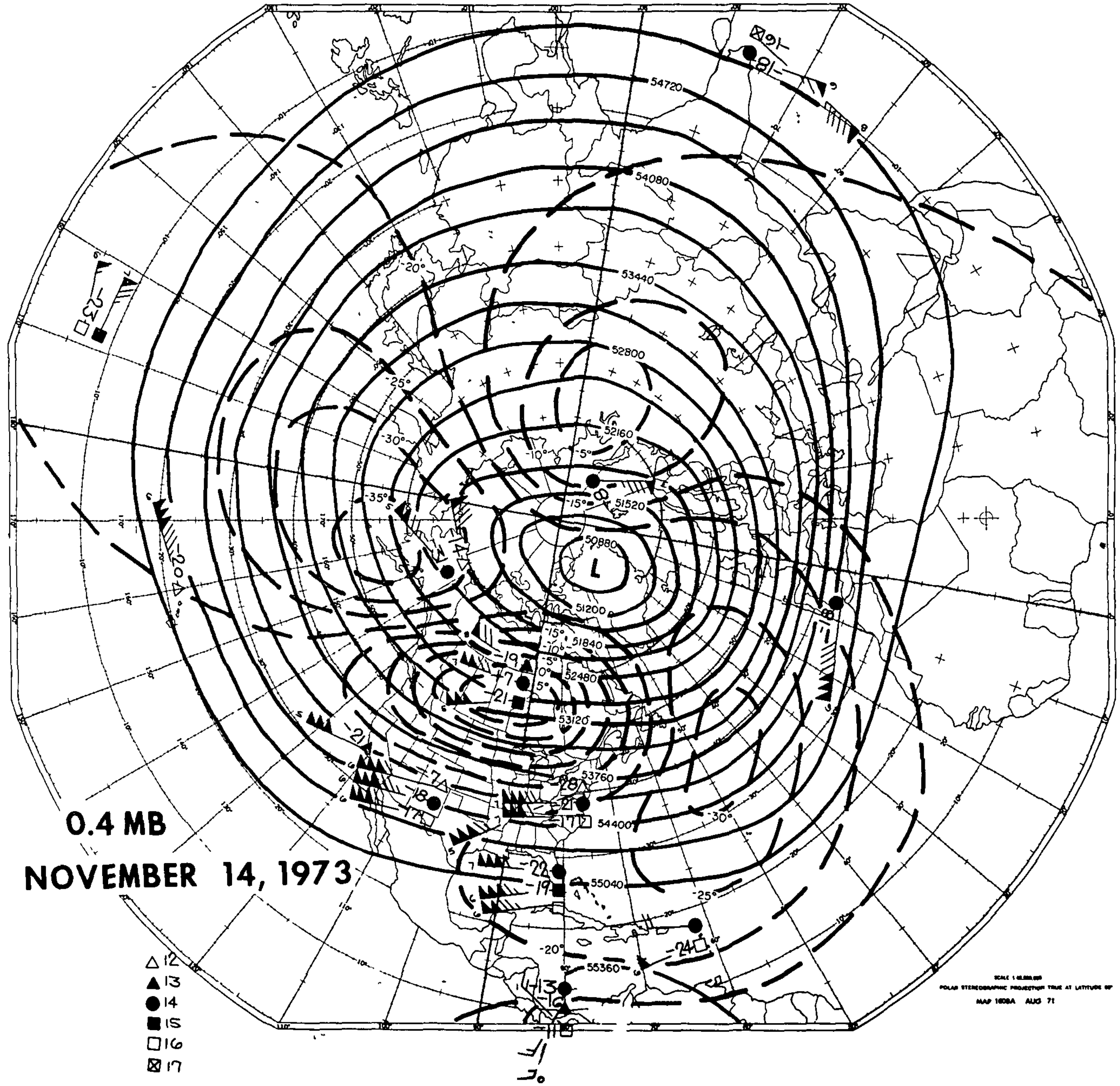
MAP 1608A AUG 71



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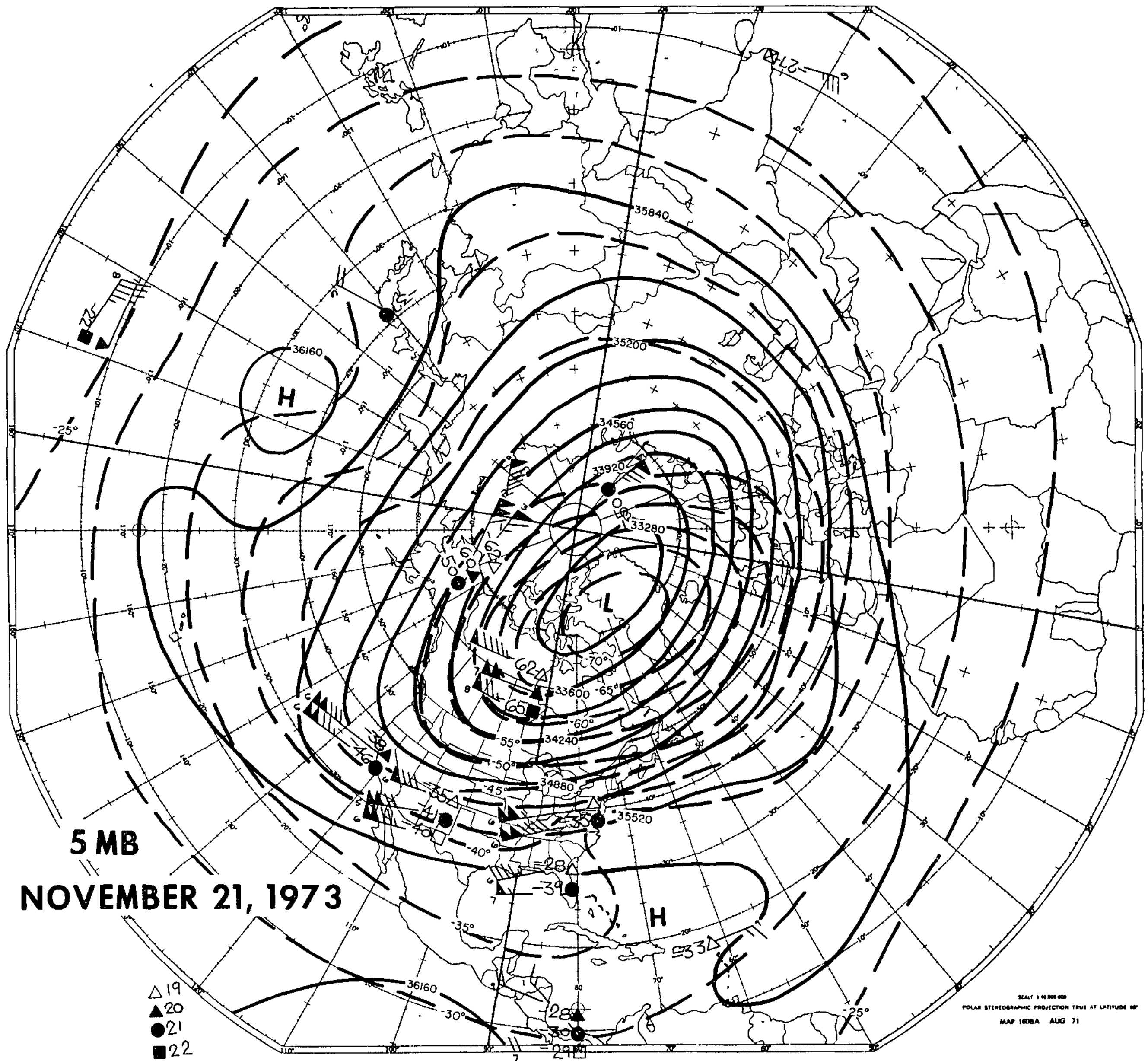

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NOVEMBER 21, 1973

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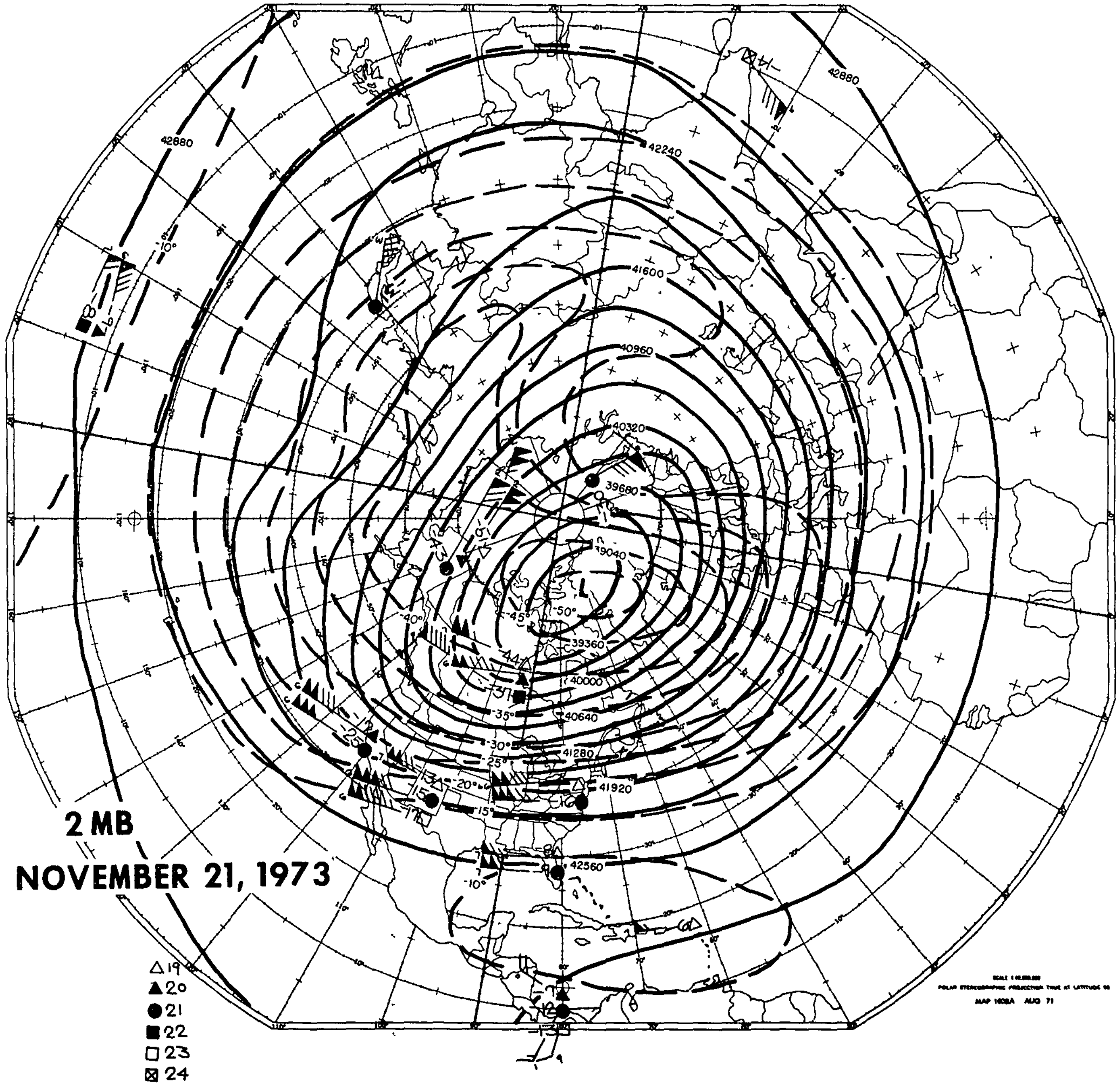
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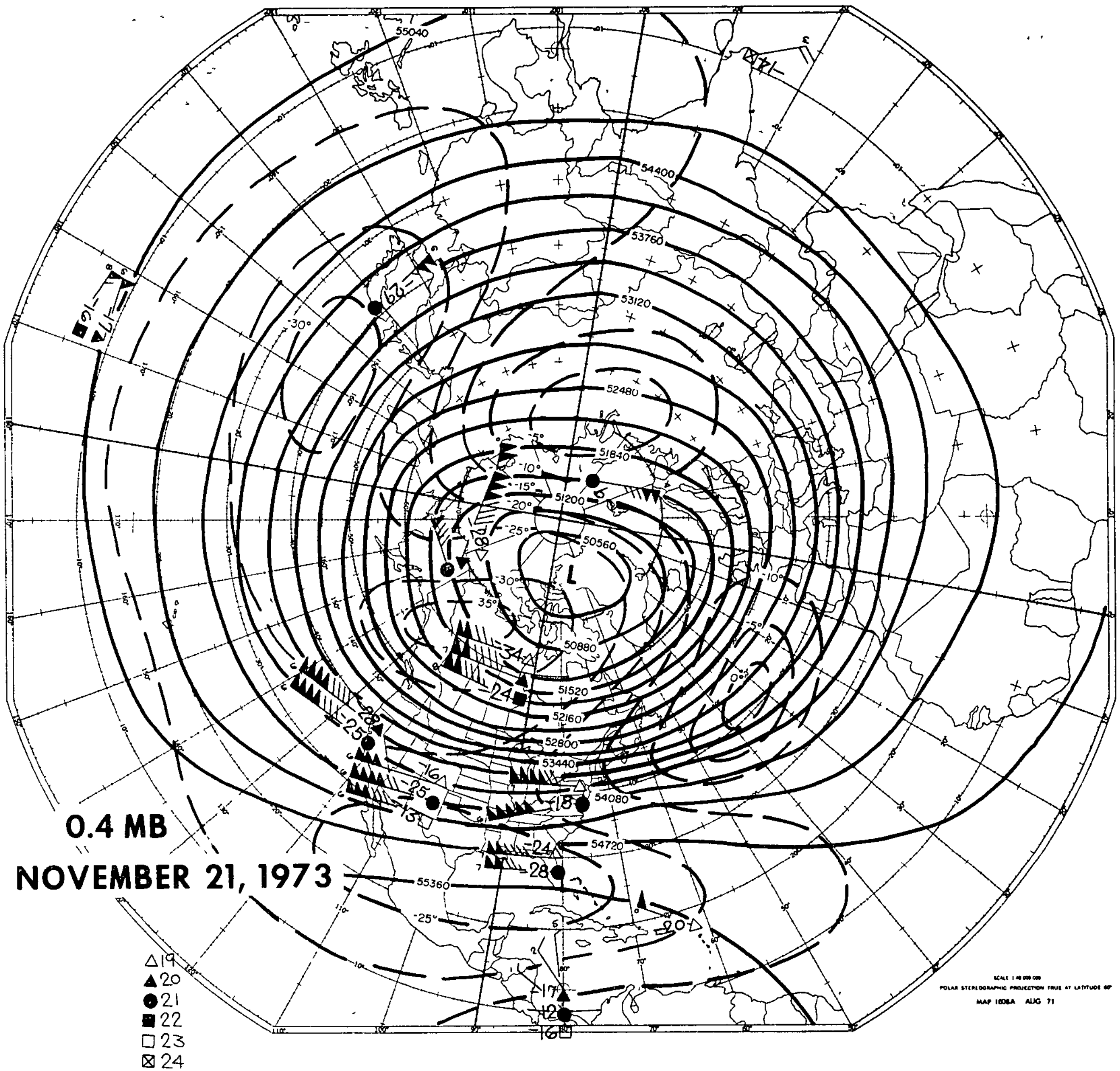
MAP 1608A AUG 71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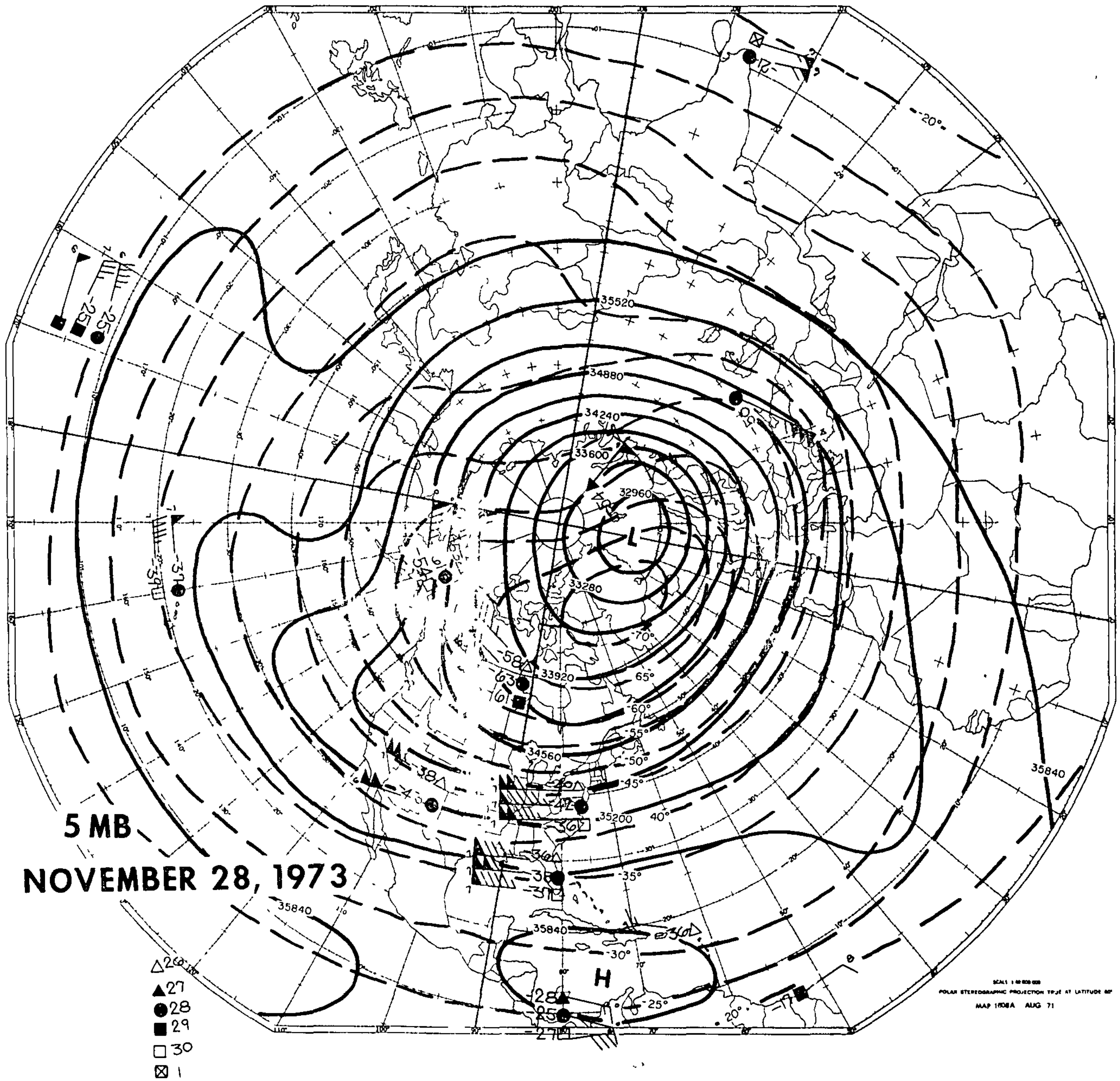
MAP 1608A AUG 71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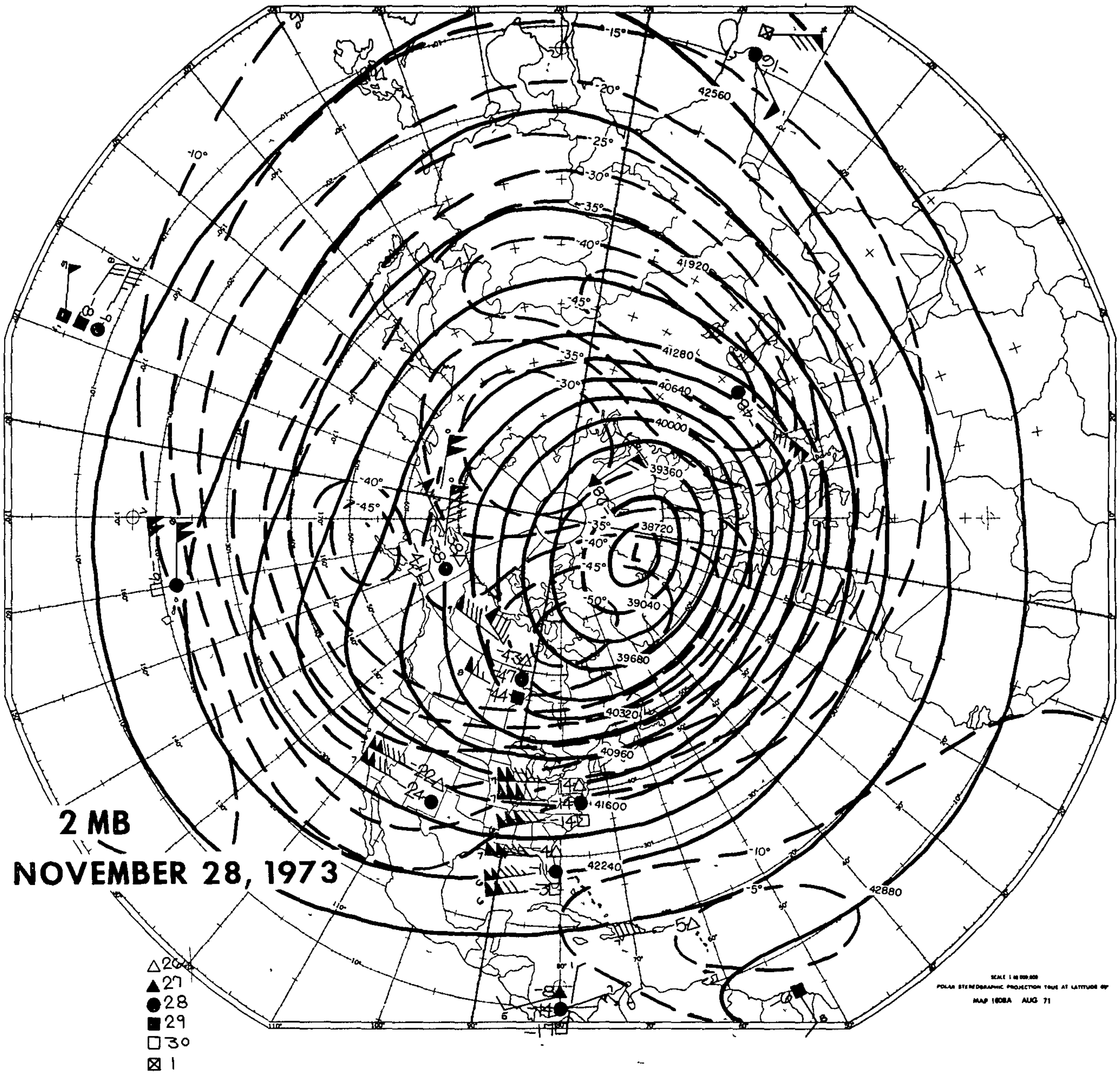
POLAR STEREOGRAPHIC PROJECTION TRUE AT LATITUDE 60°
MAP 1608A AUG 71



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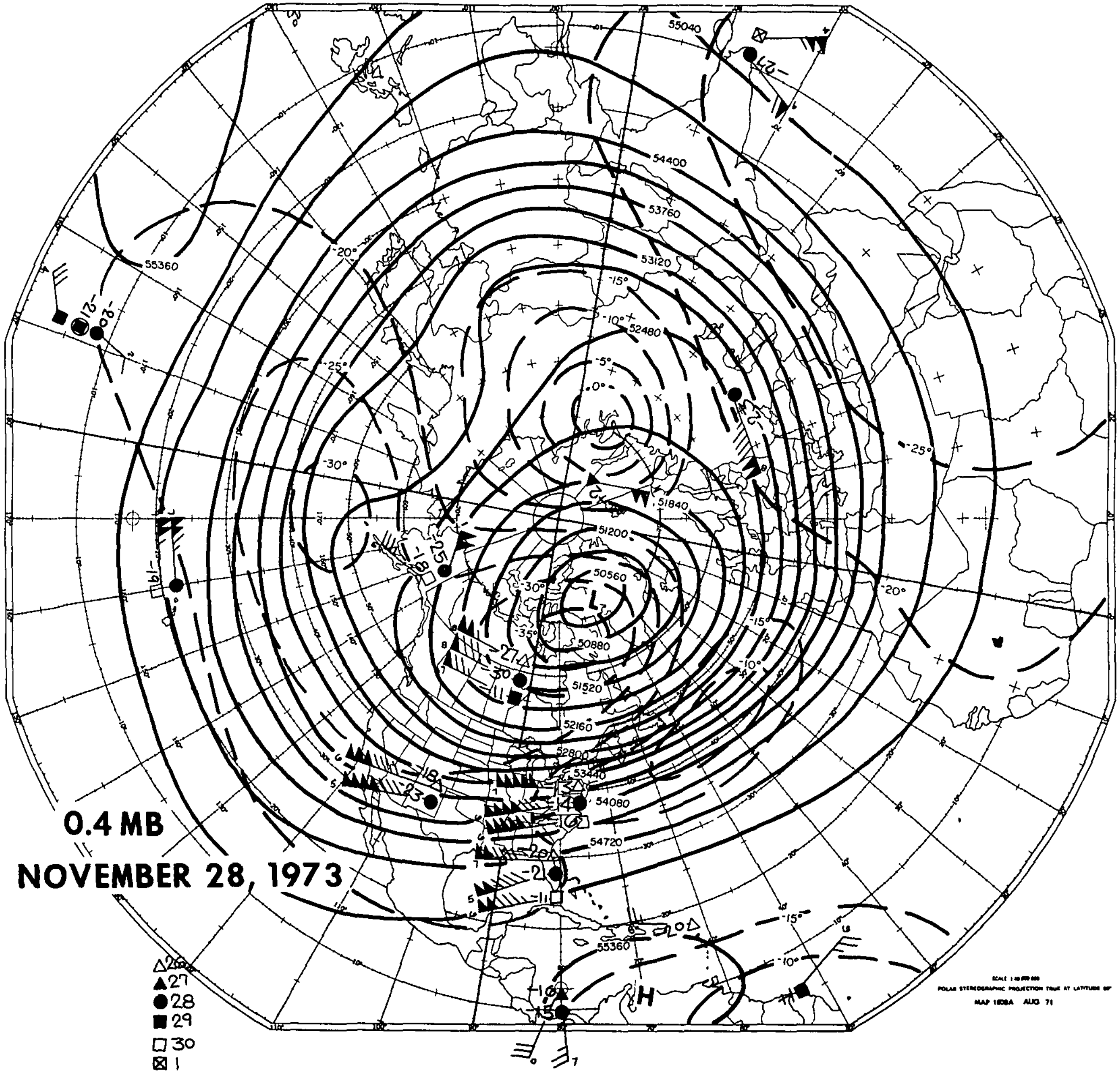
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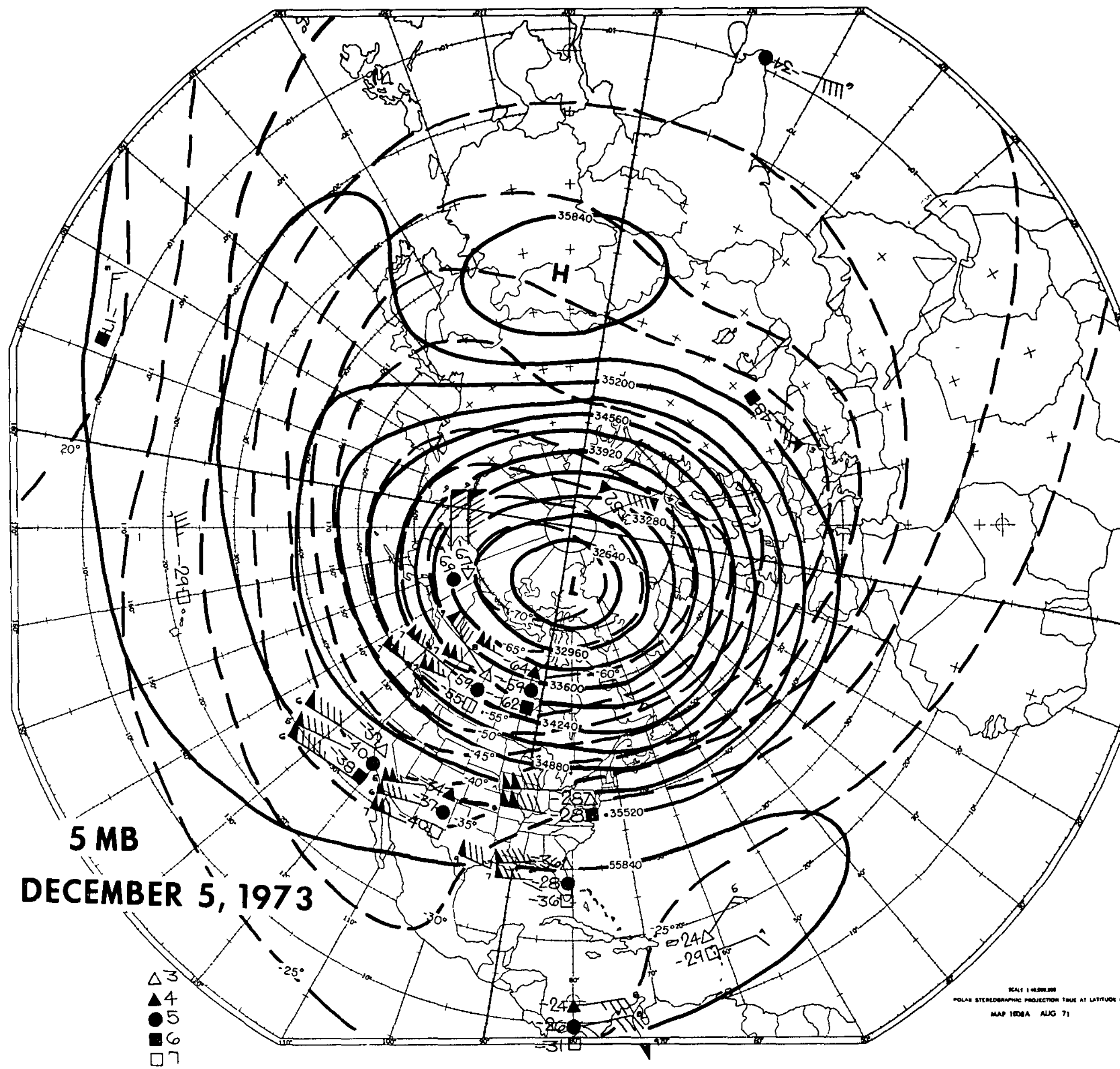
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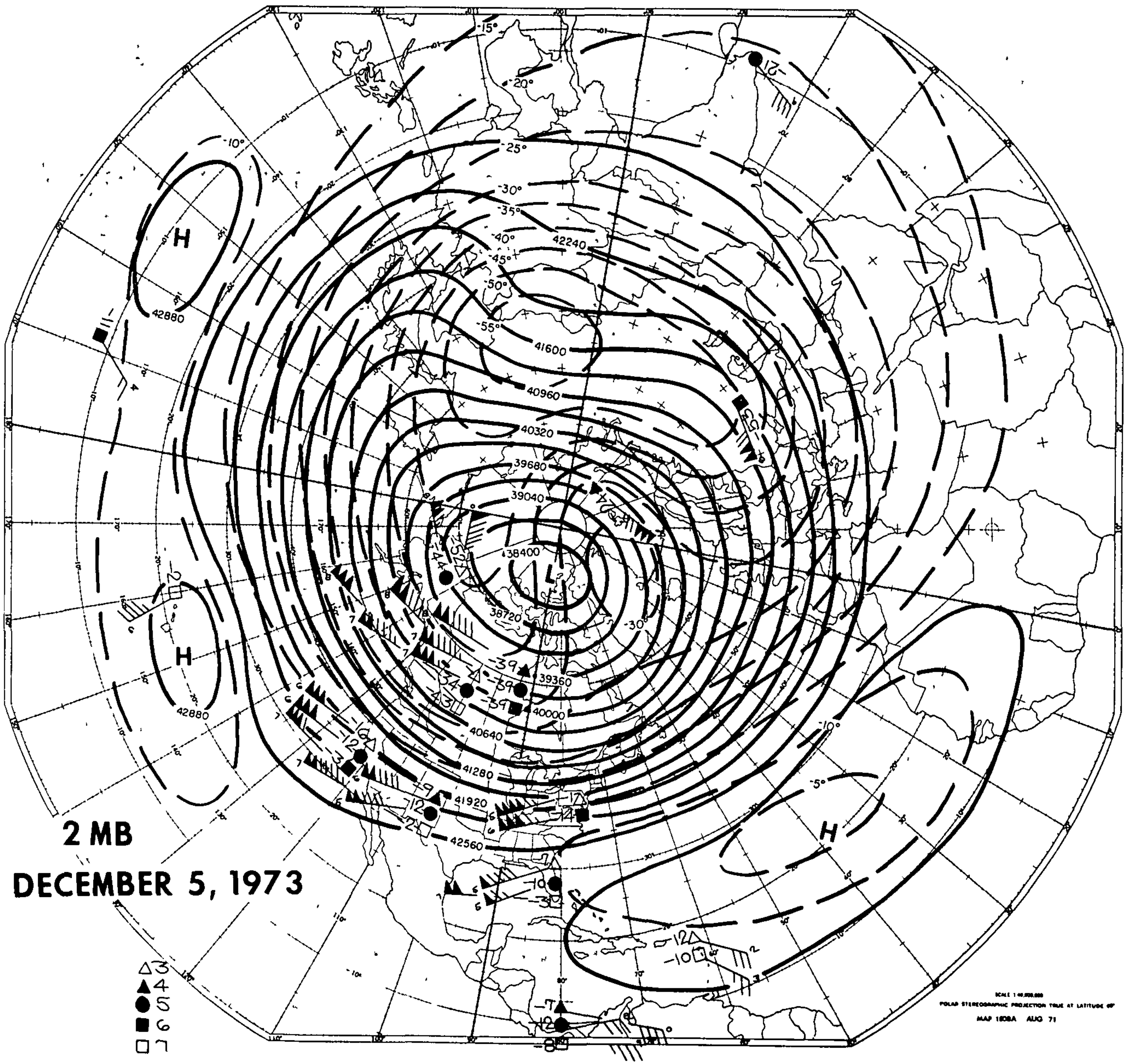

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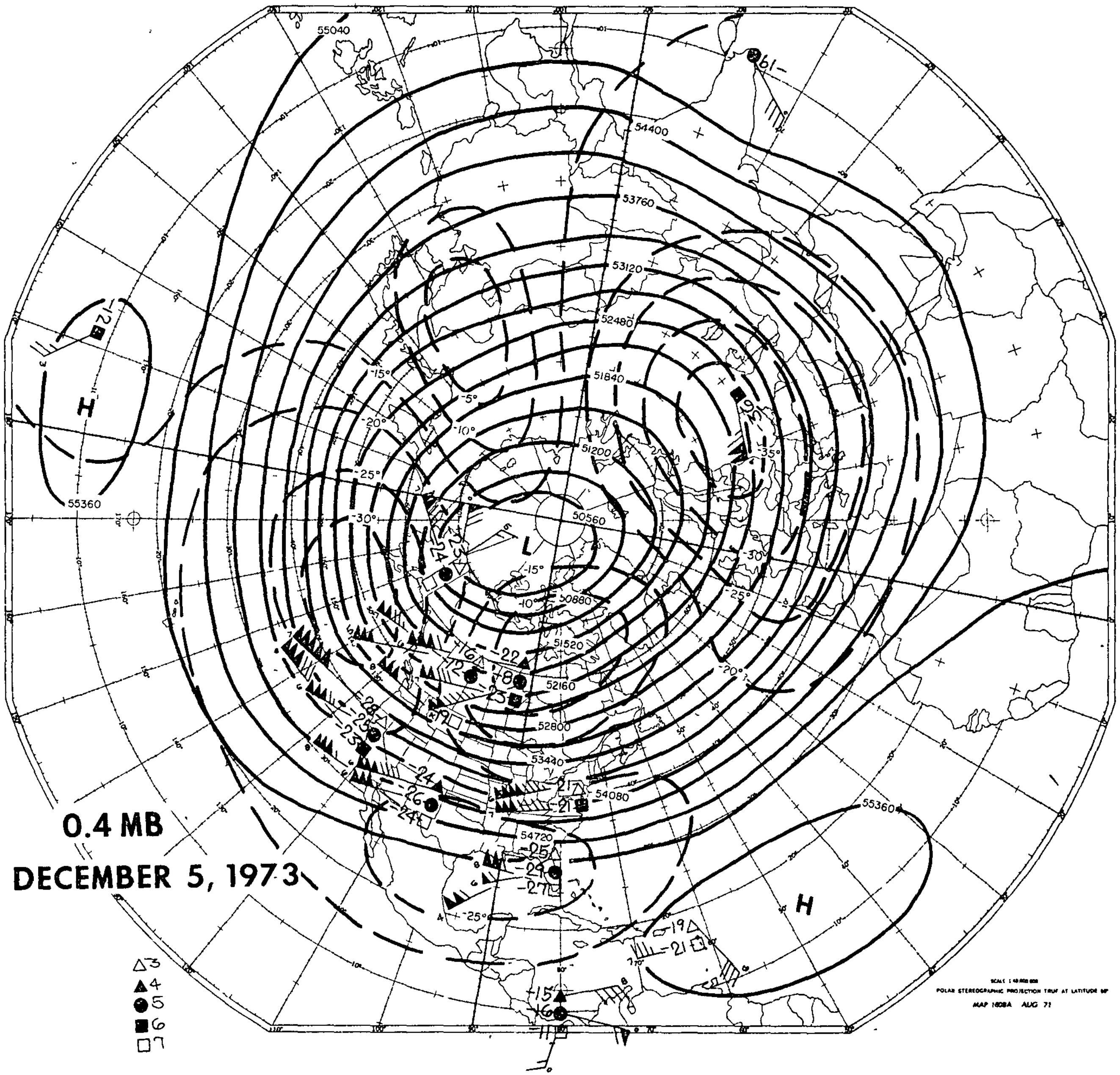

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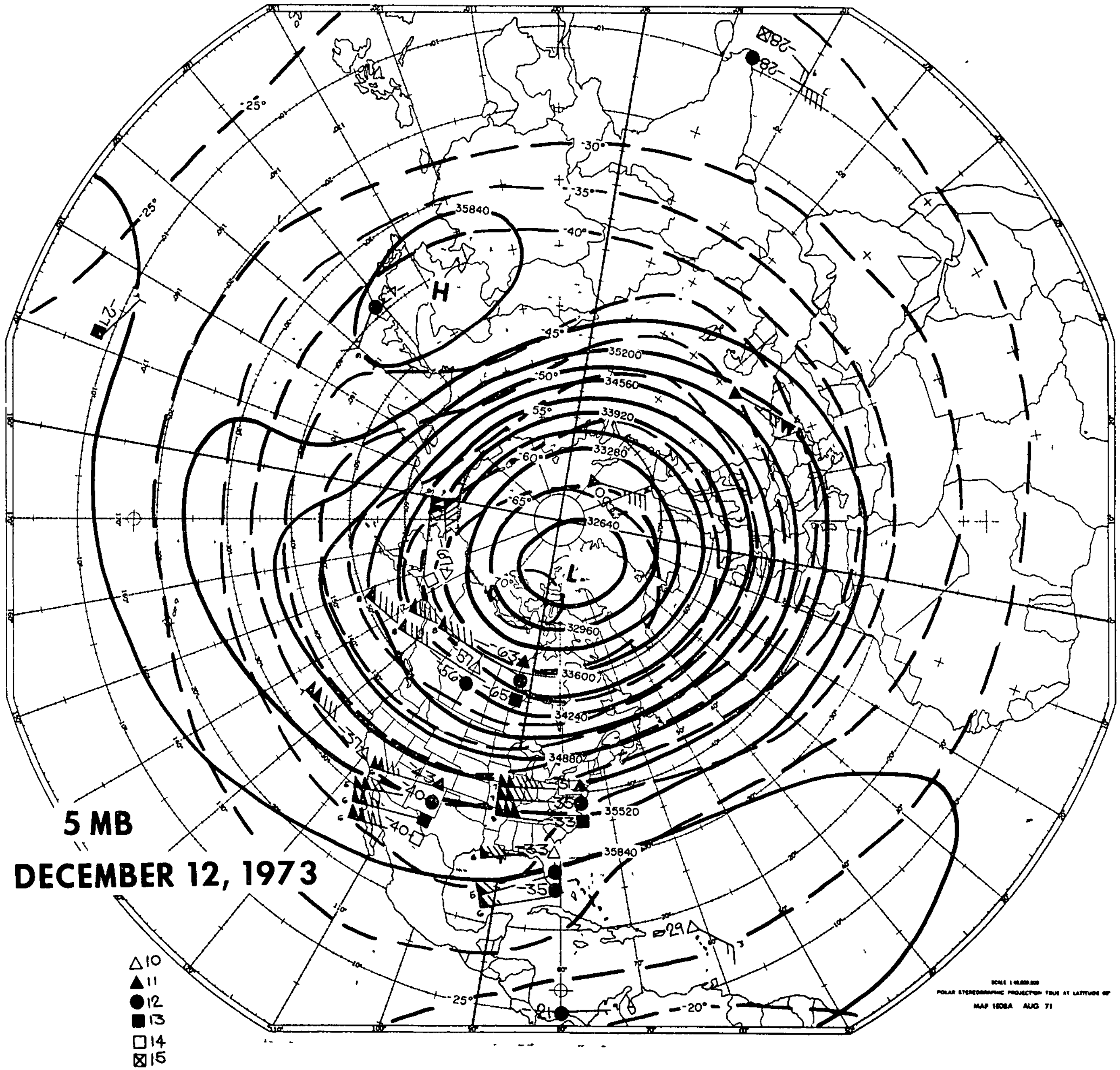

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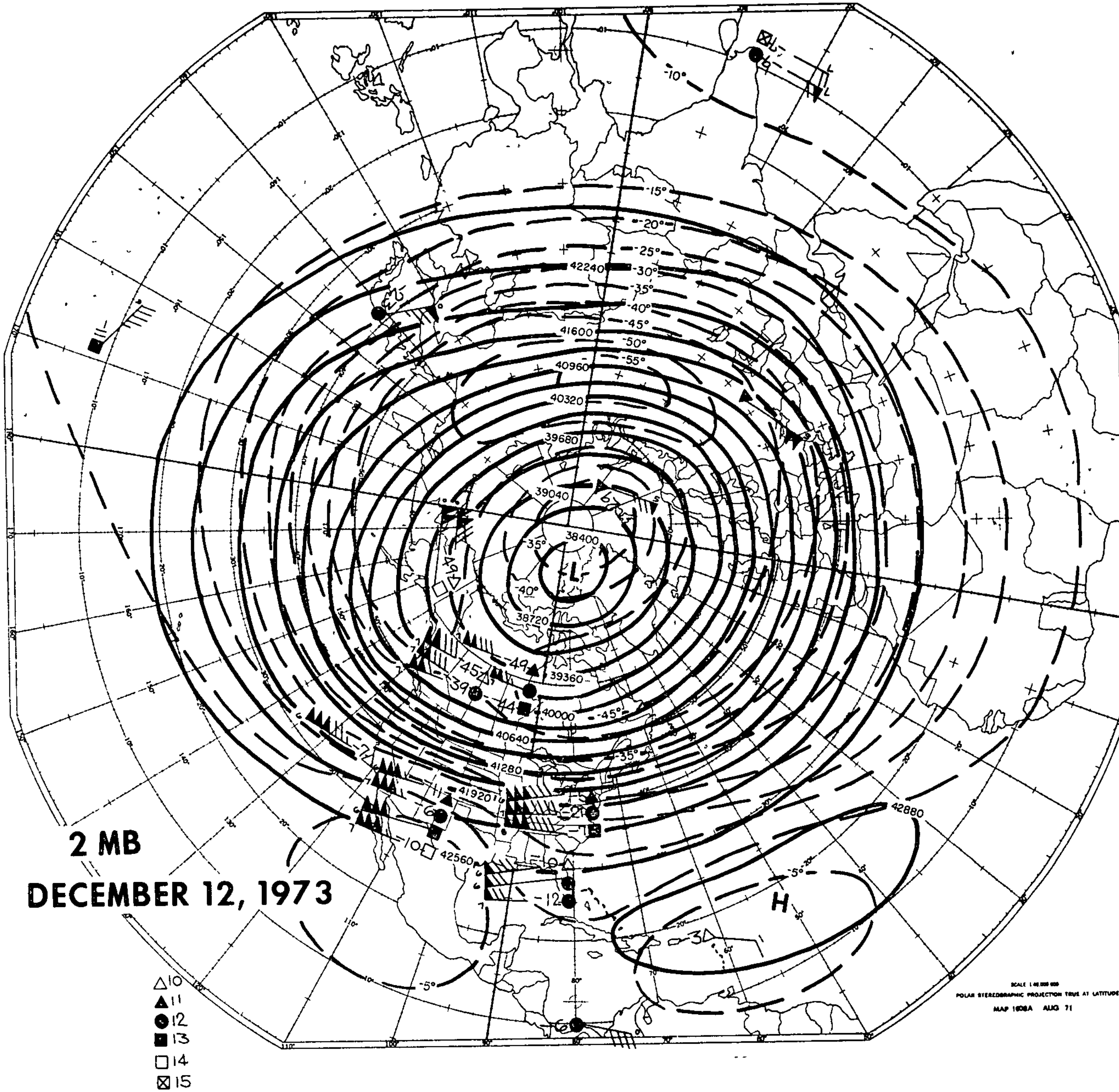

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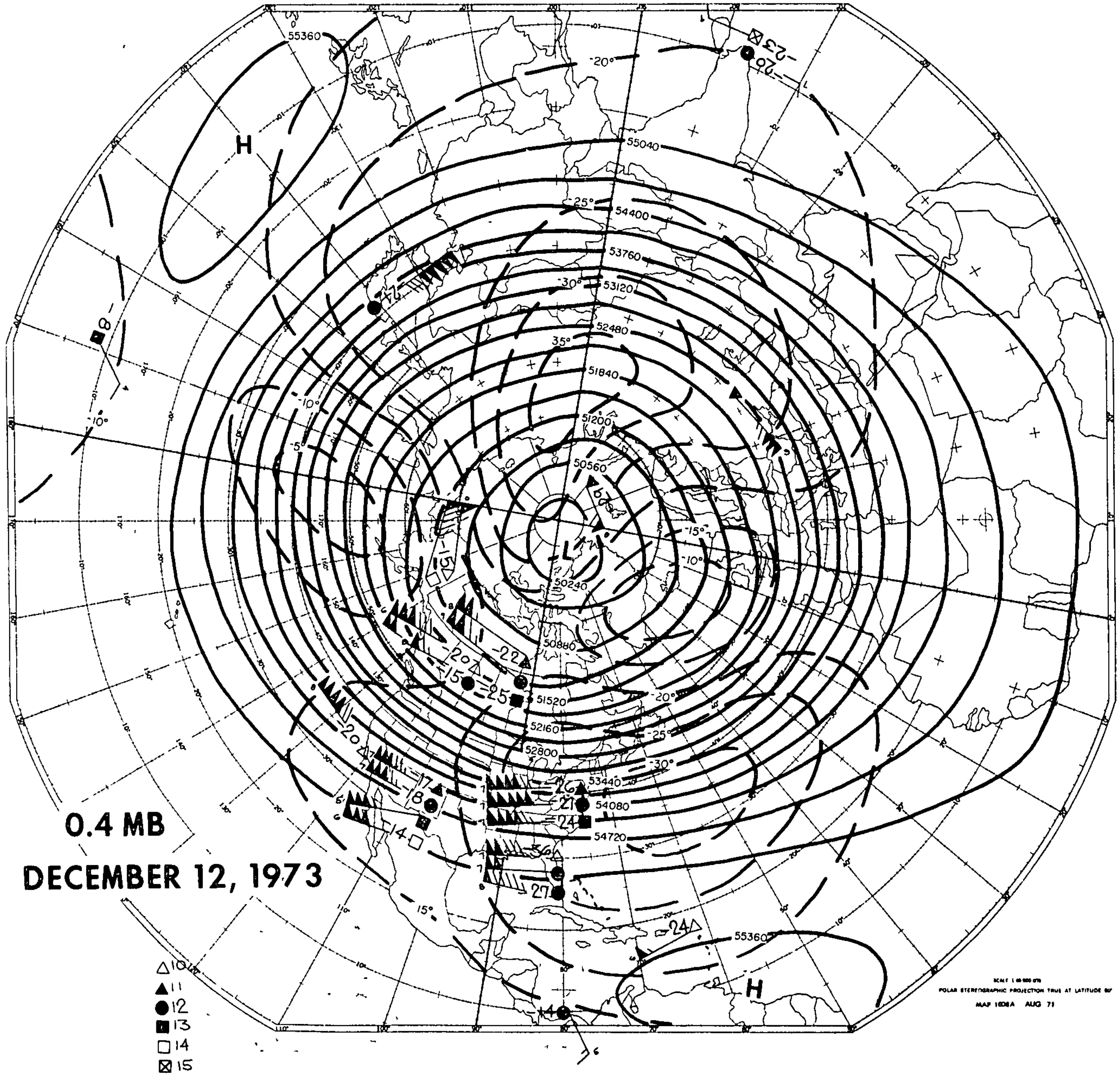

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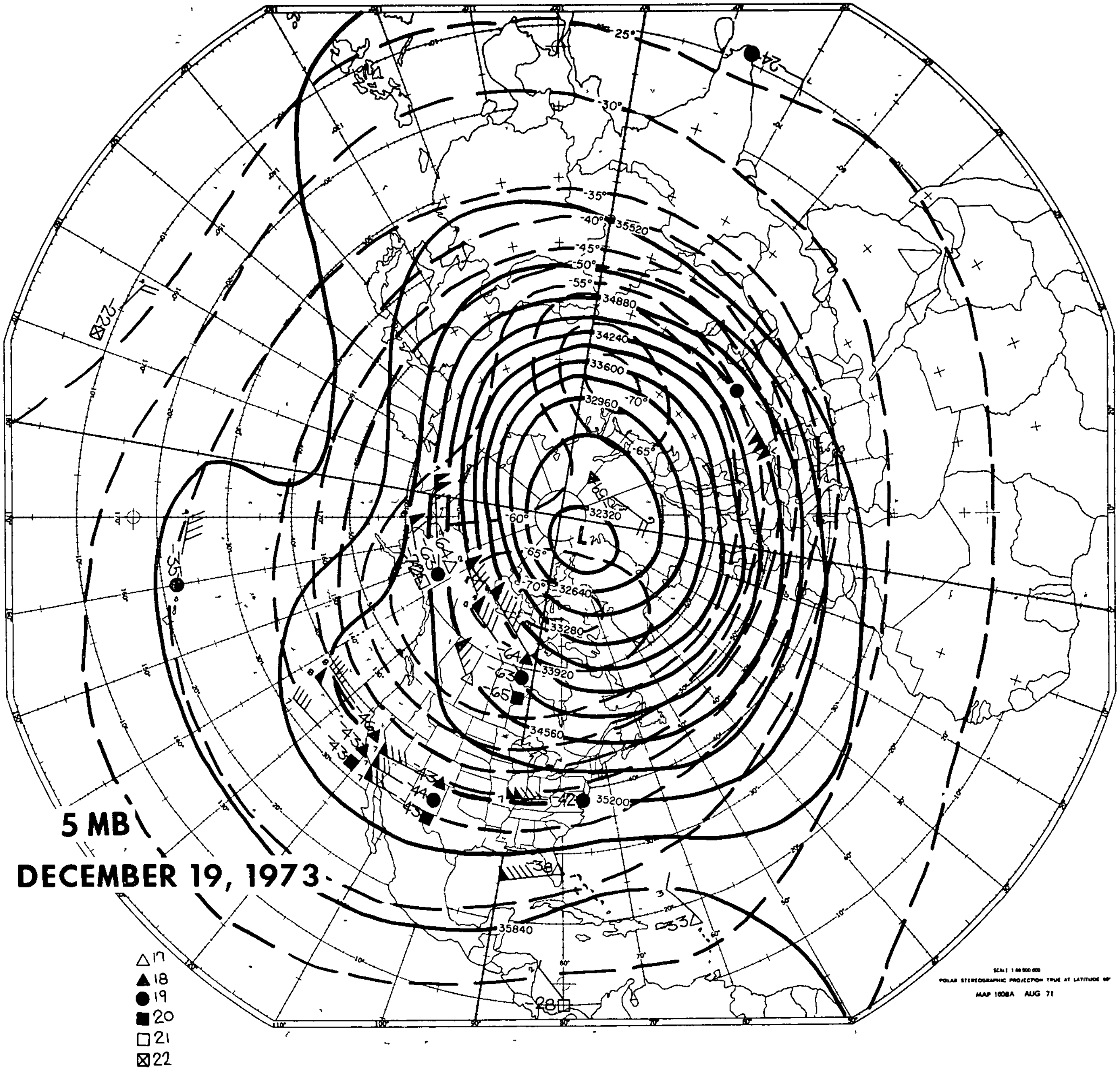

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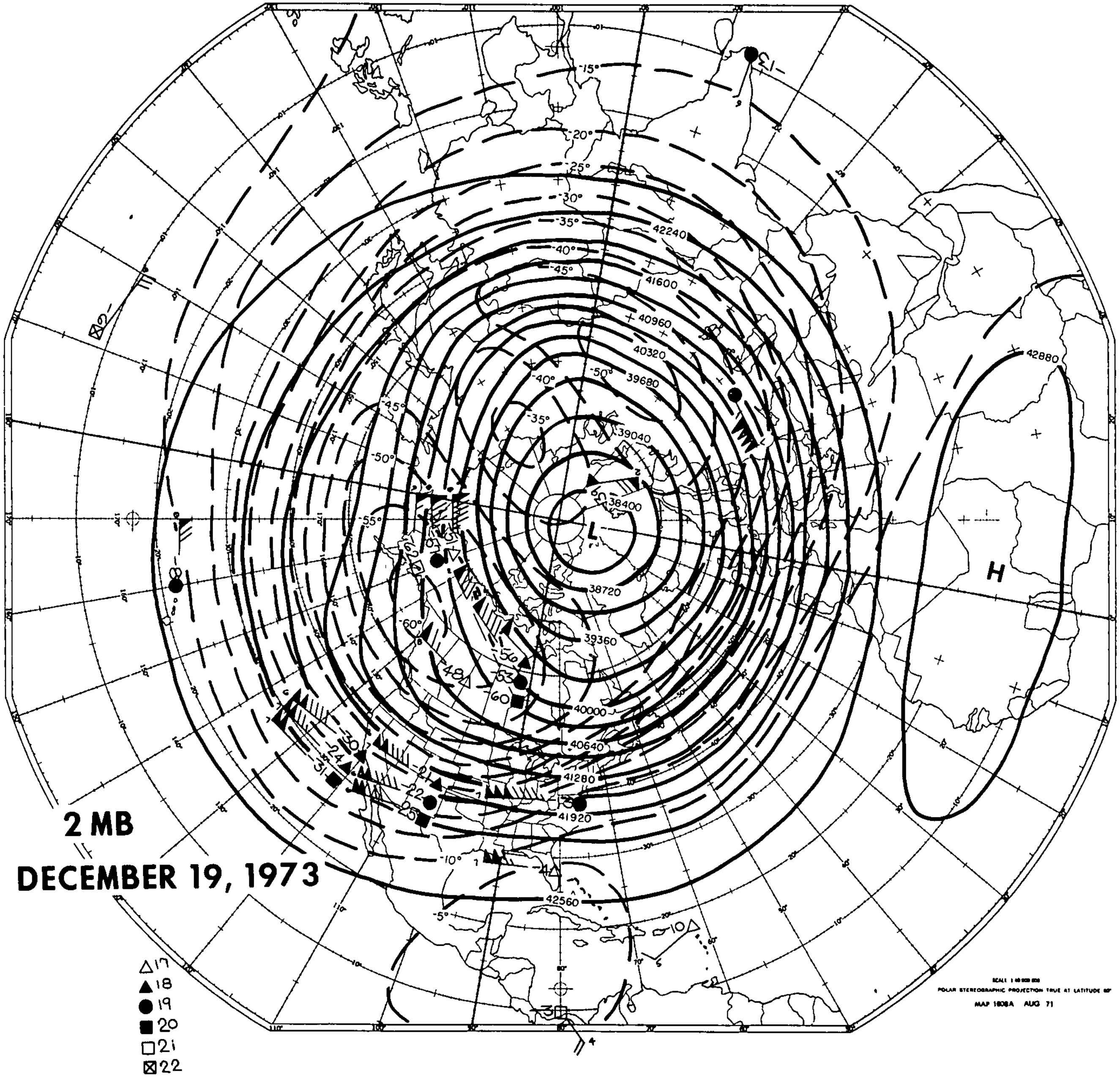

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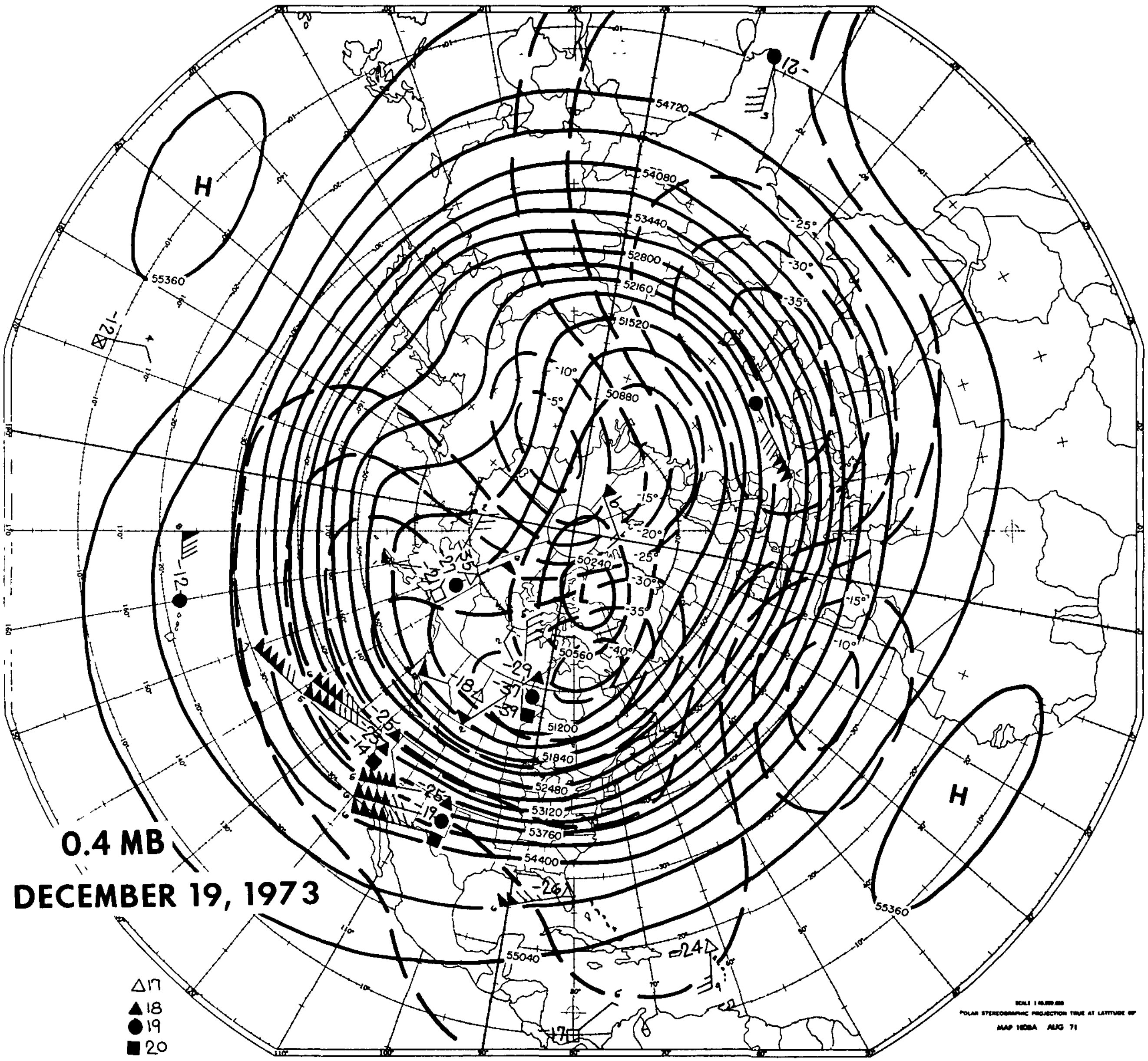

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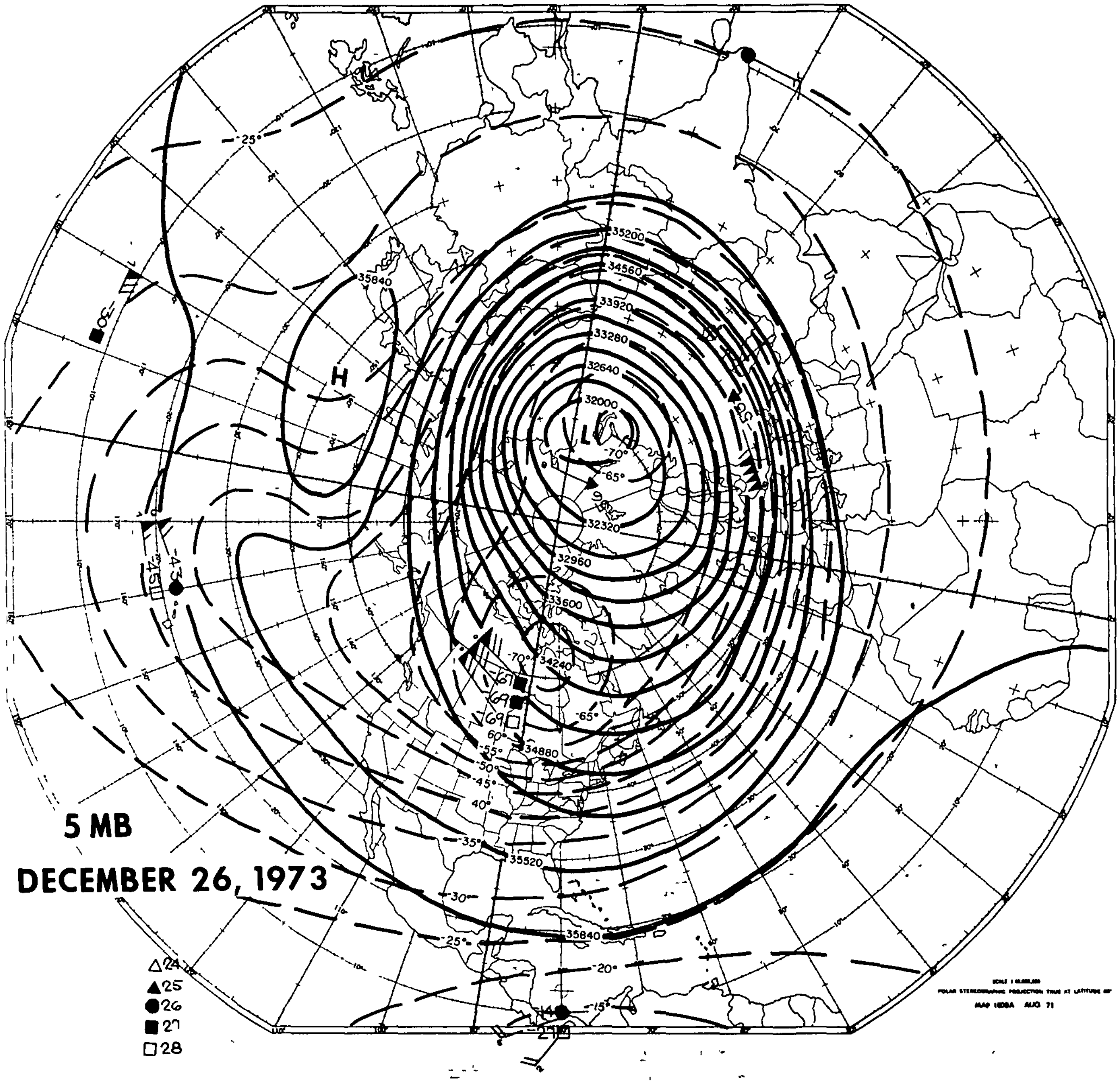

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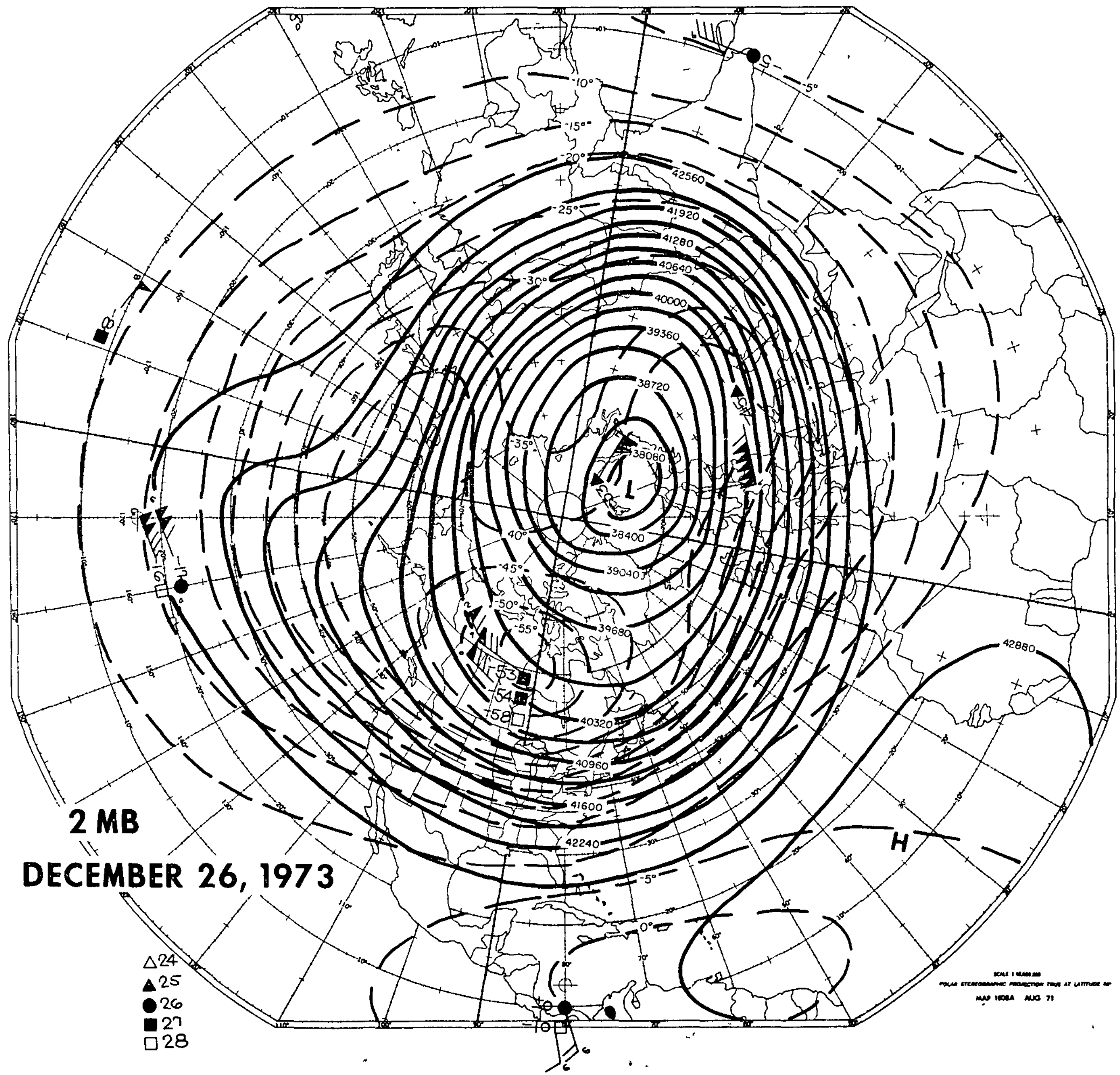

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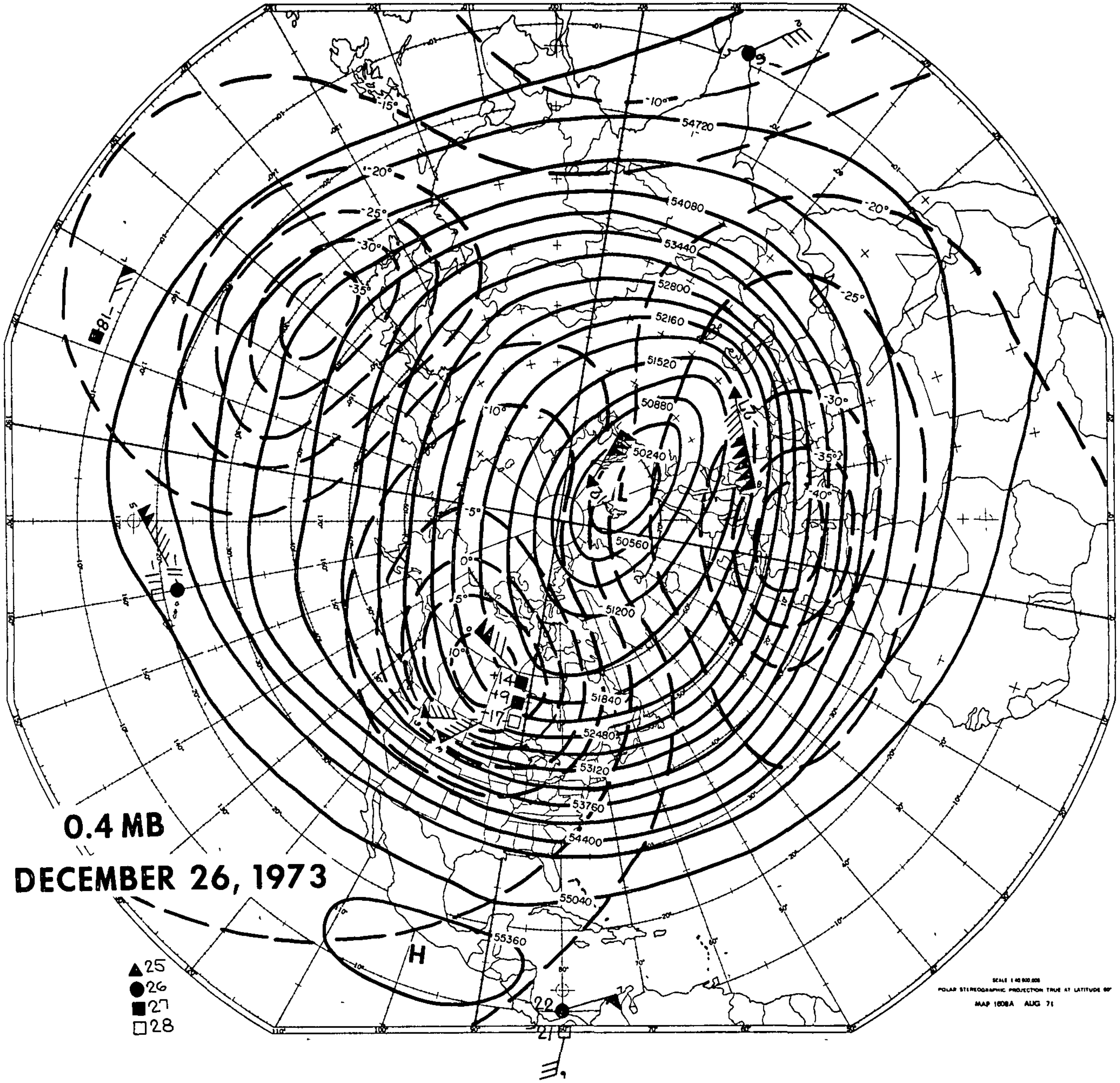

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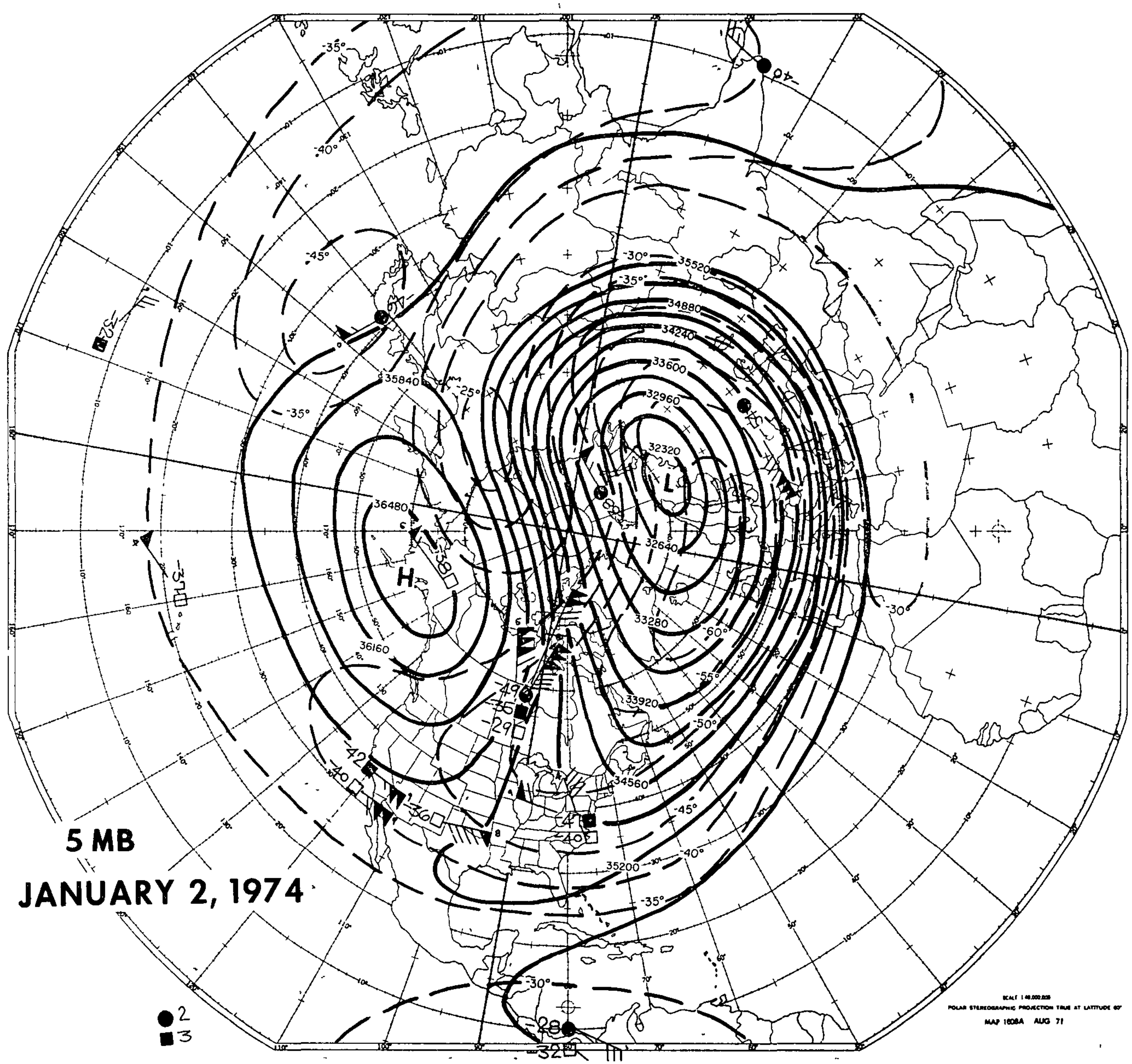

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JANUARY 2, 1974

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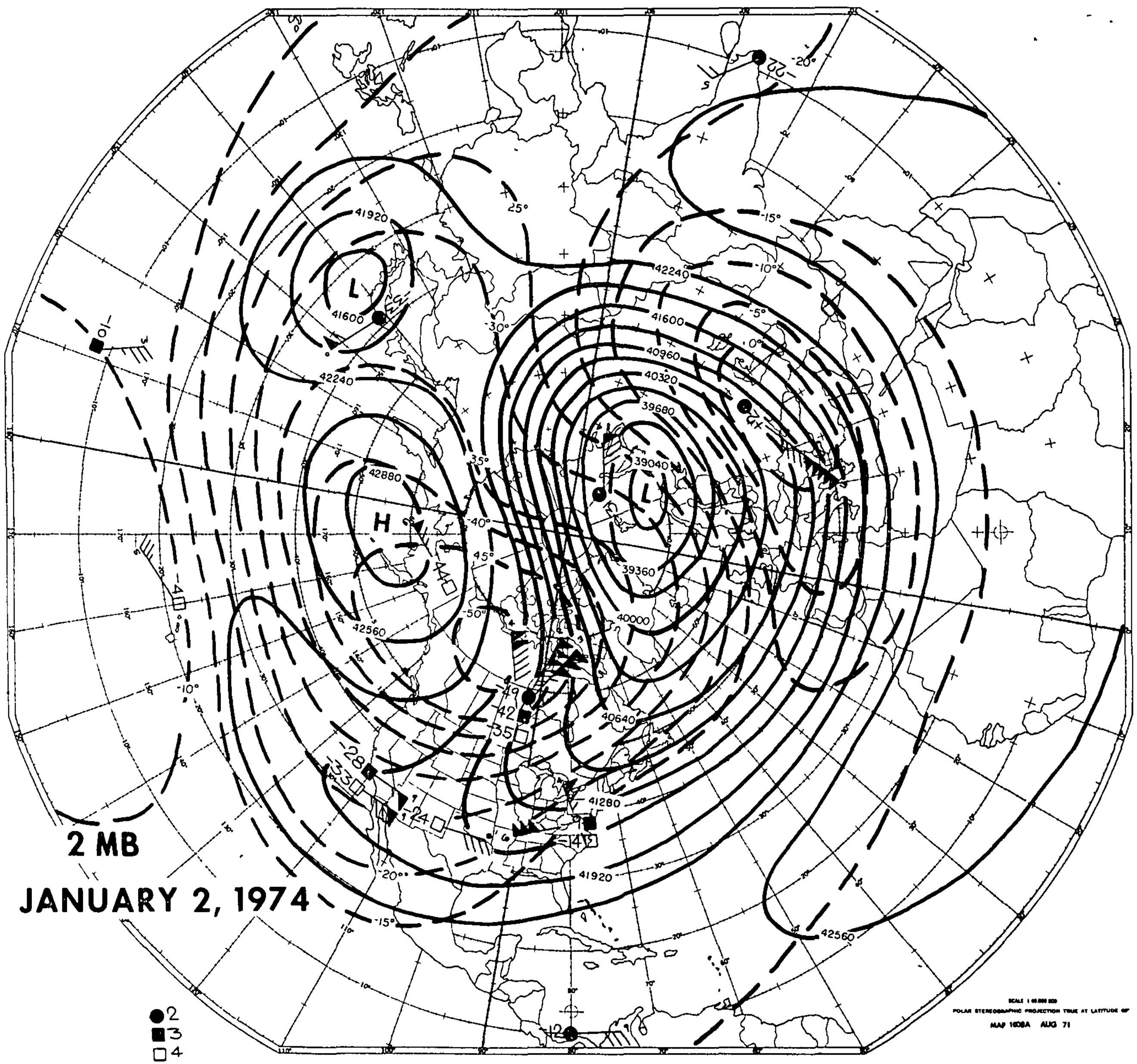
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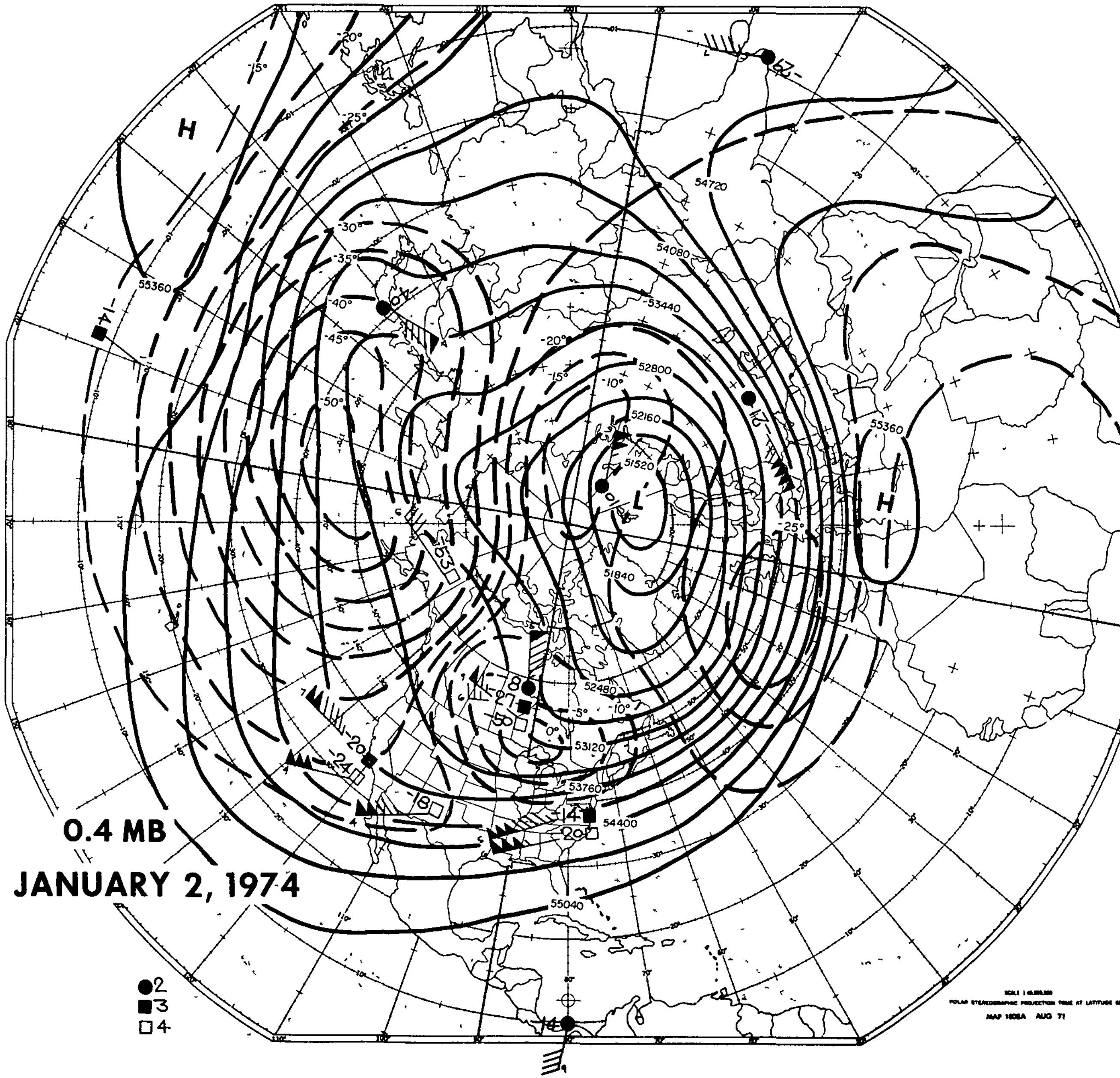

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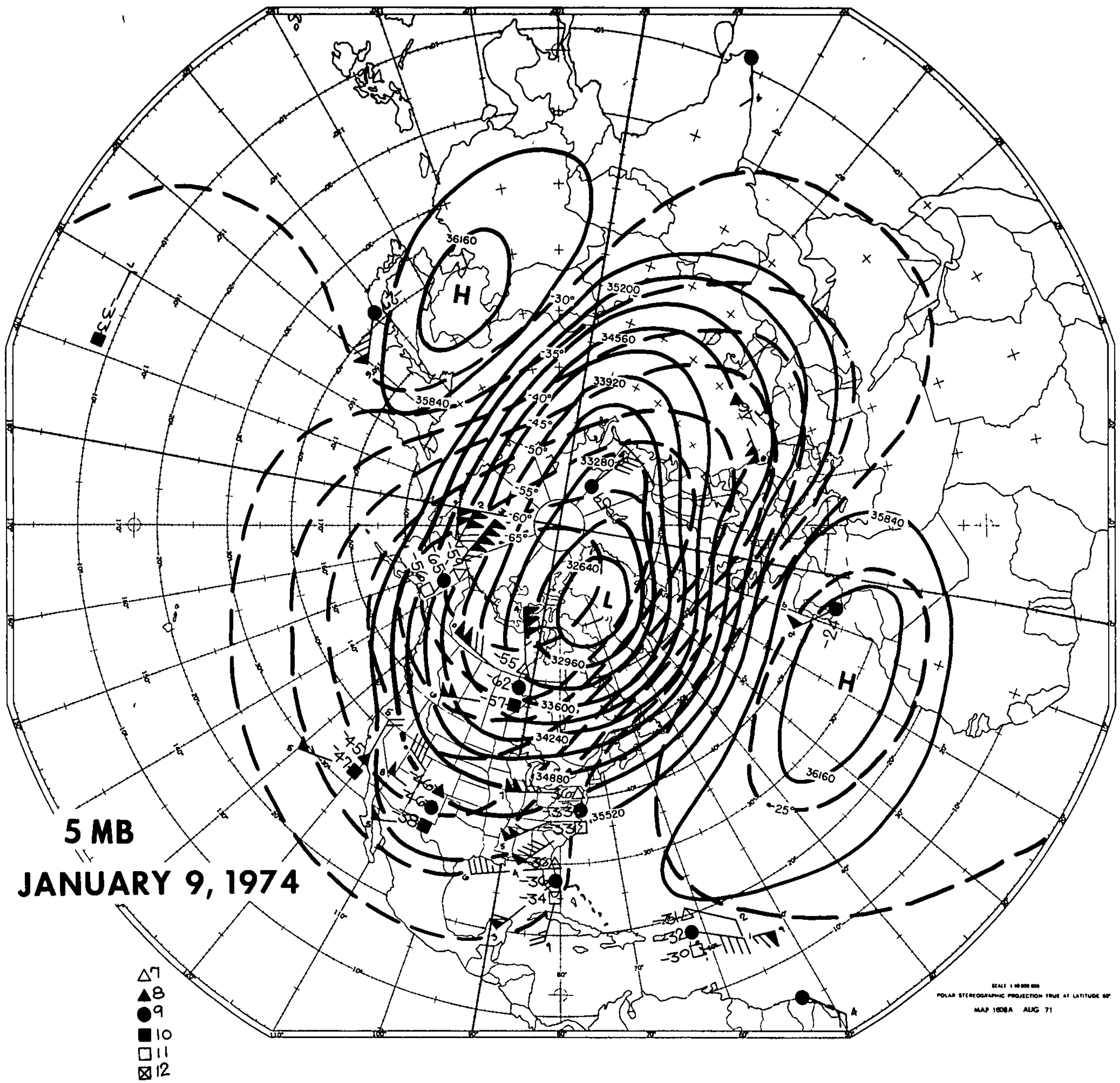

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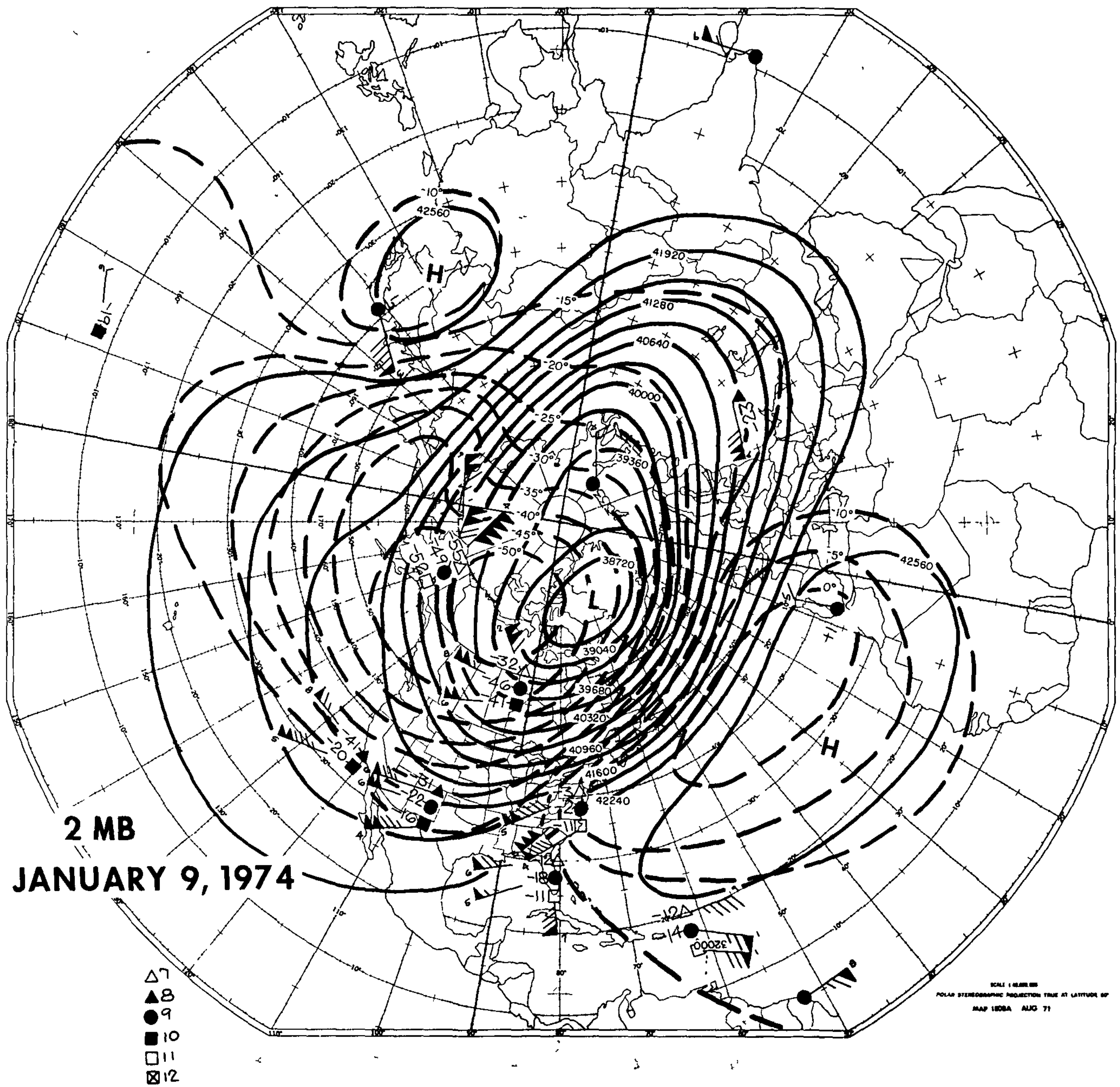
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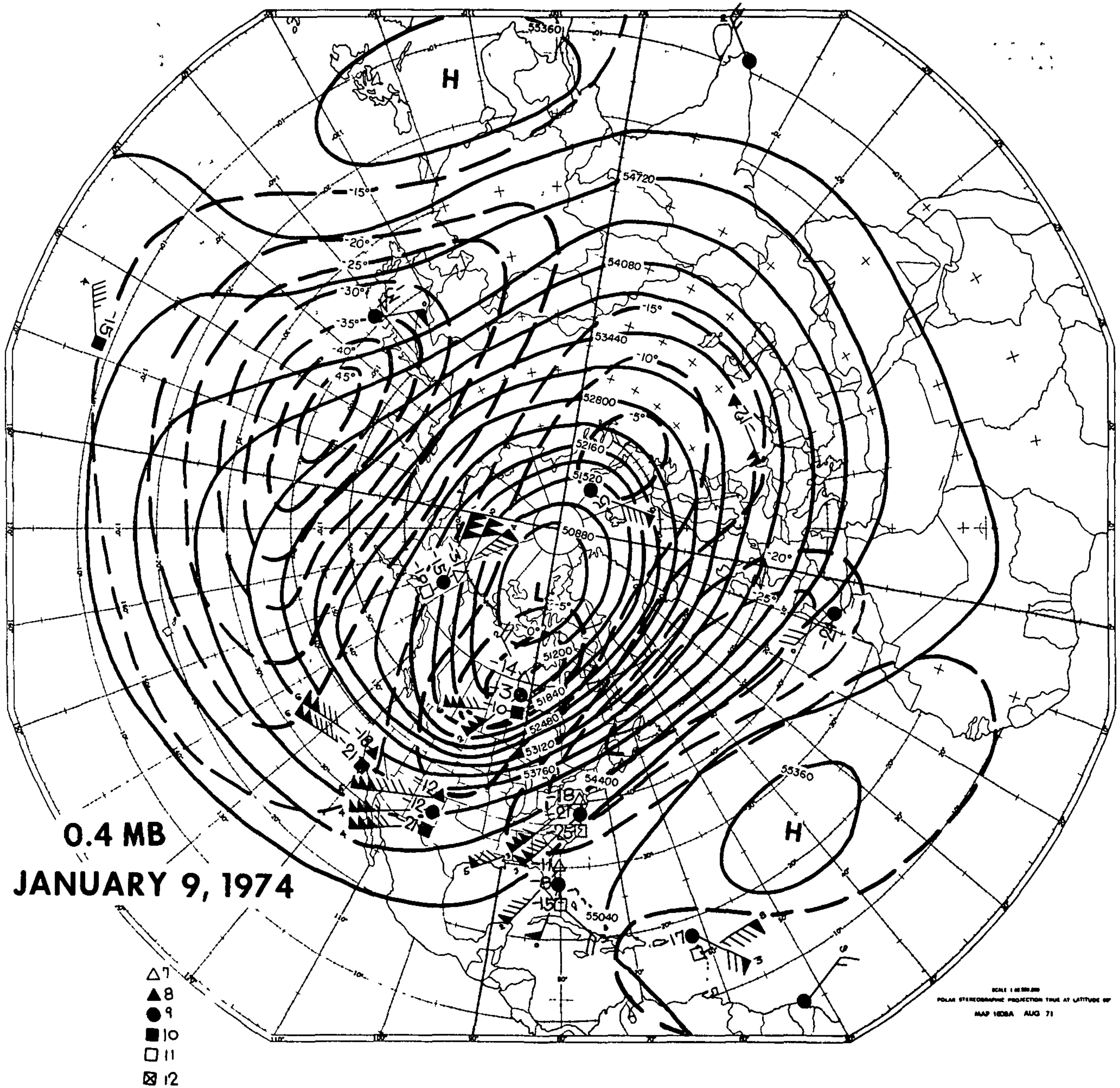

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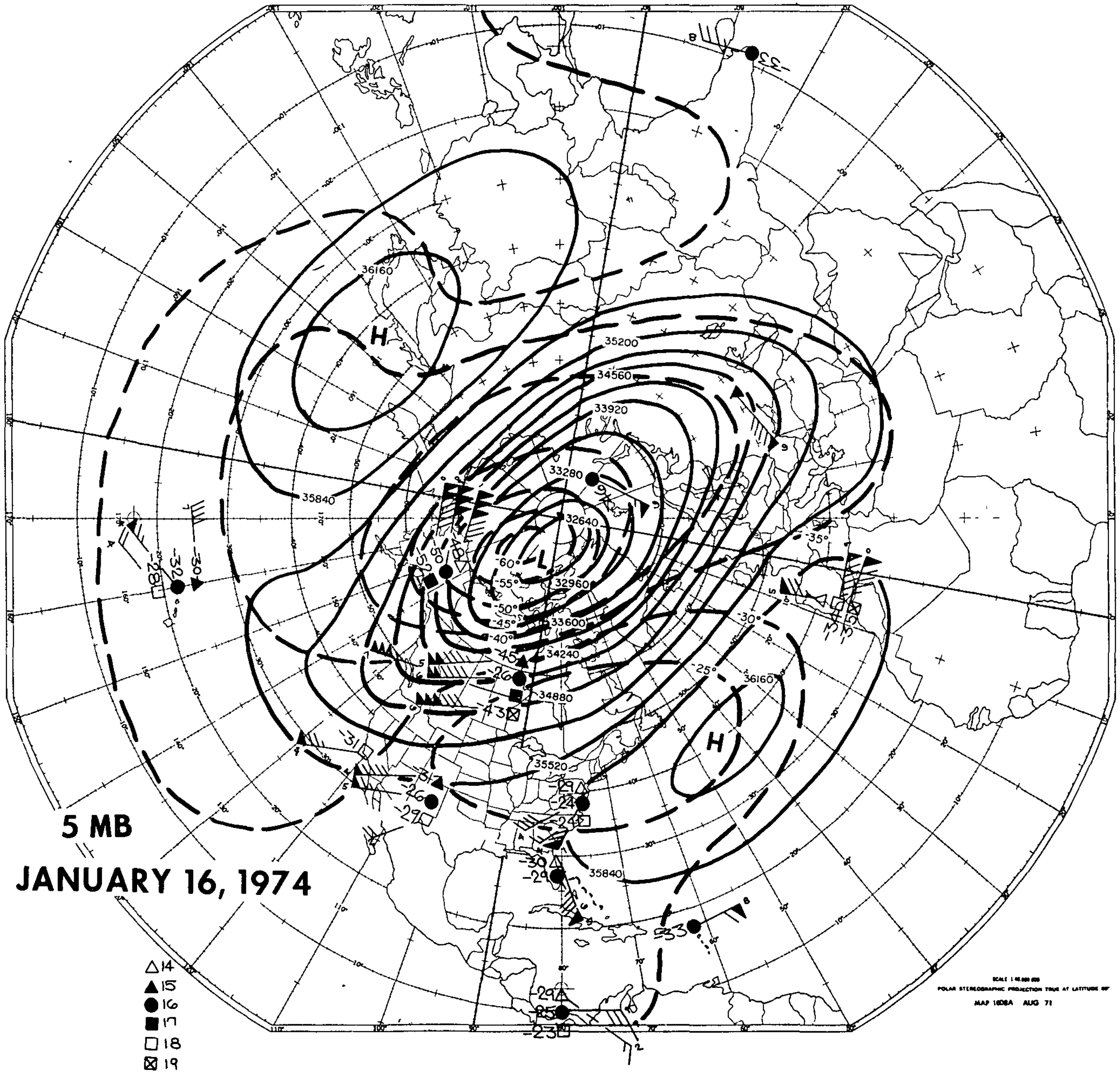
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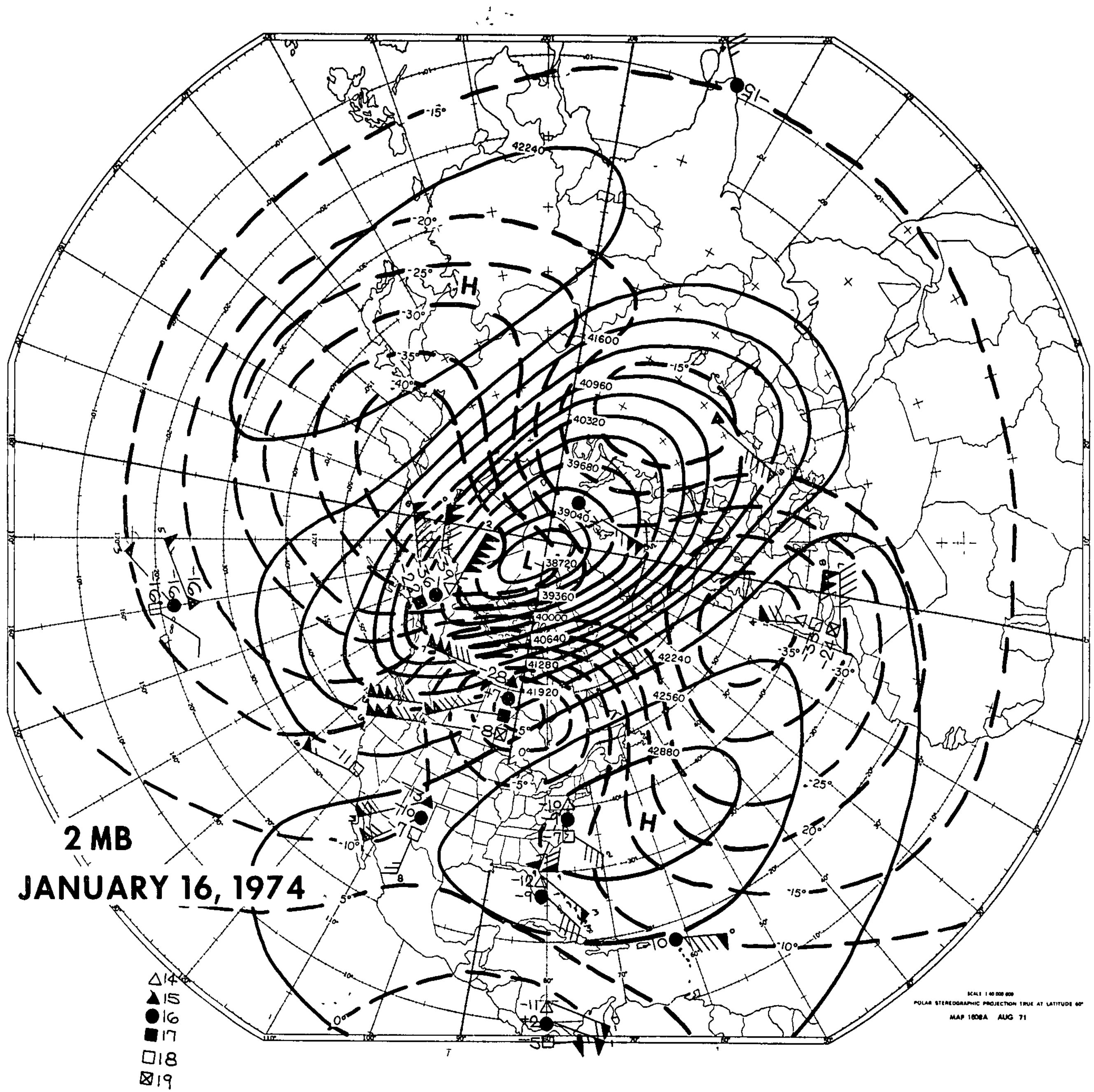
MAP 1608A AUG 71



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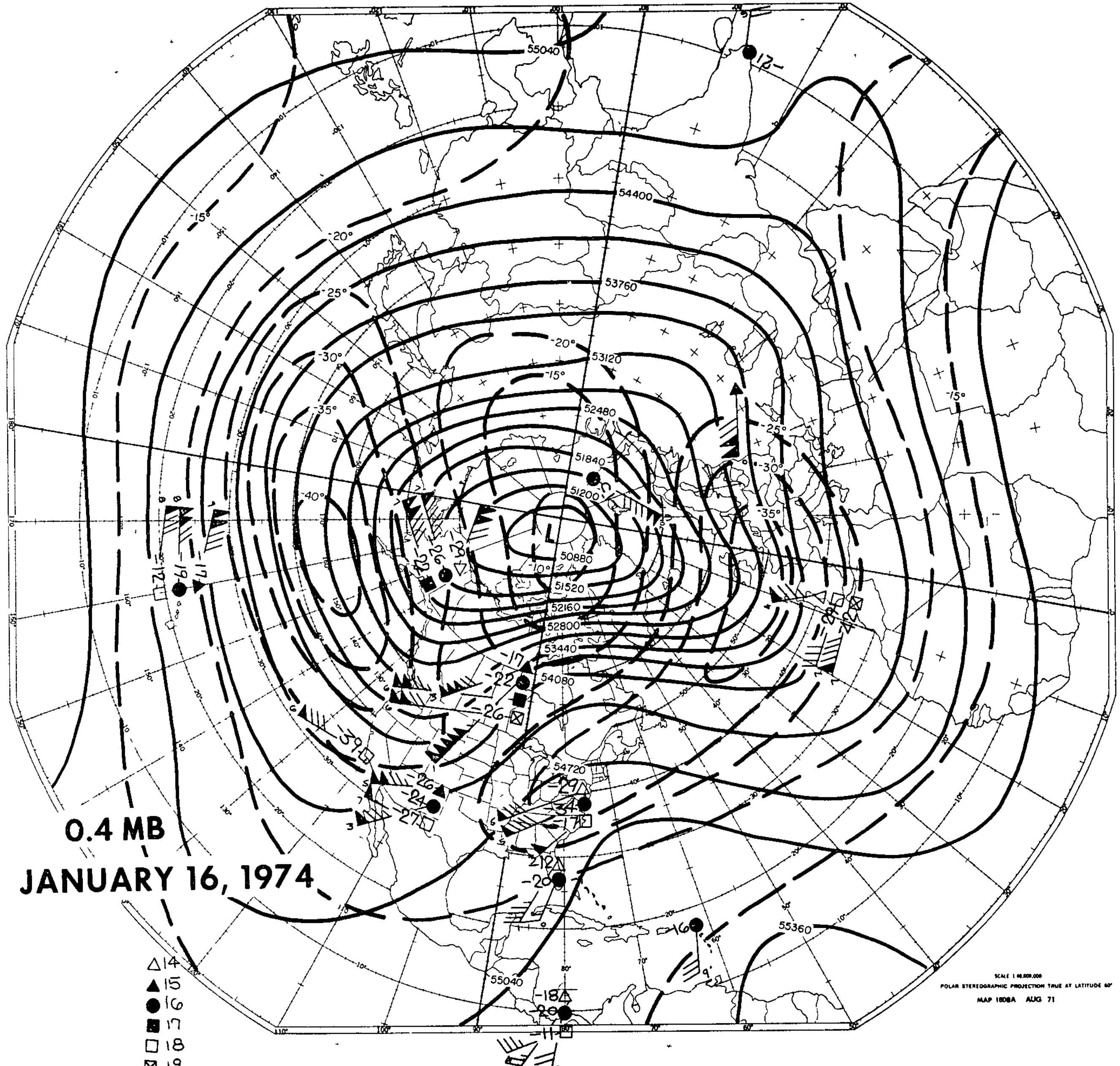
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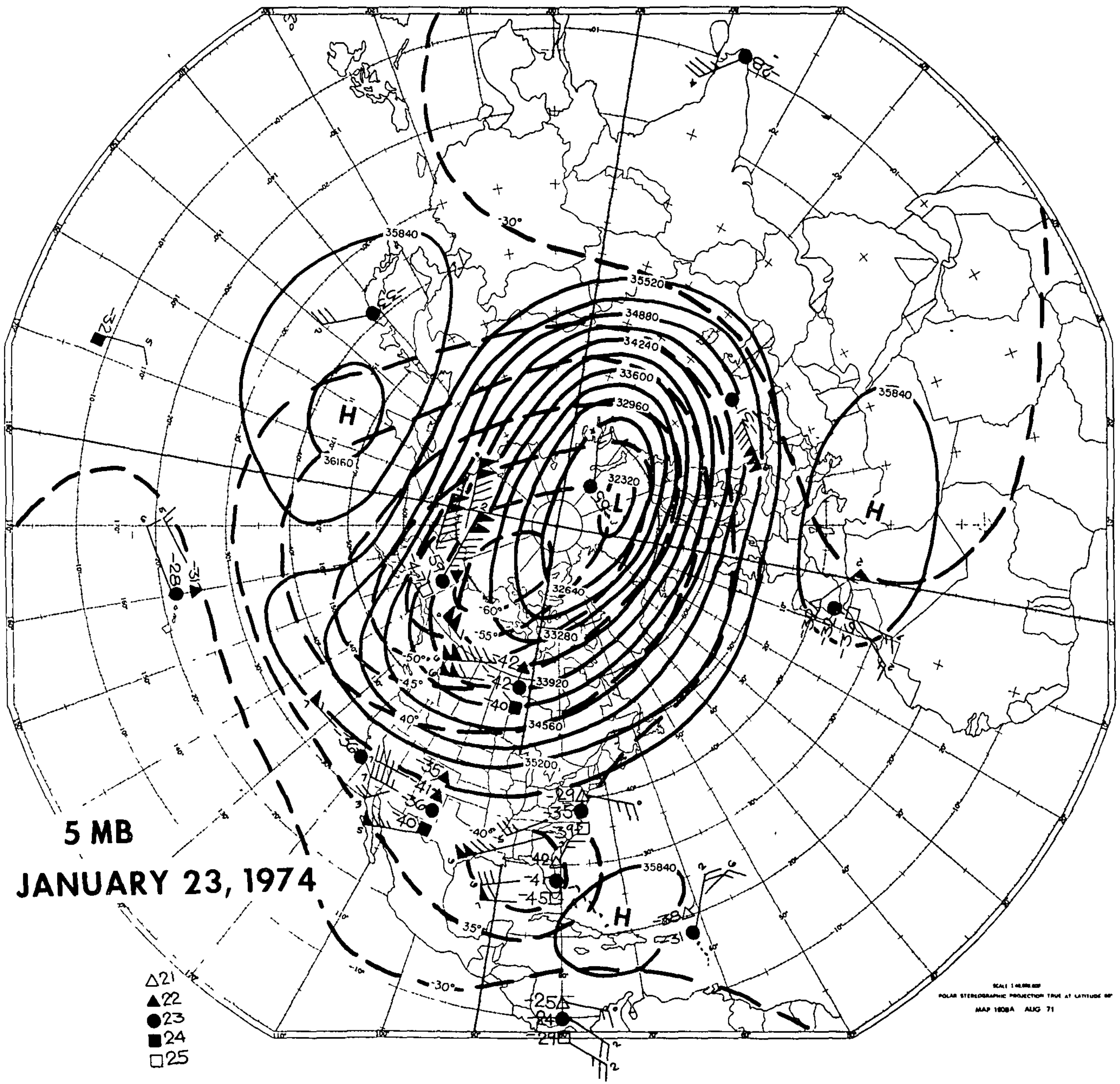
MAP 1808A AUG 71



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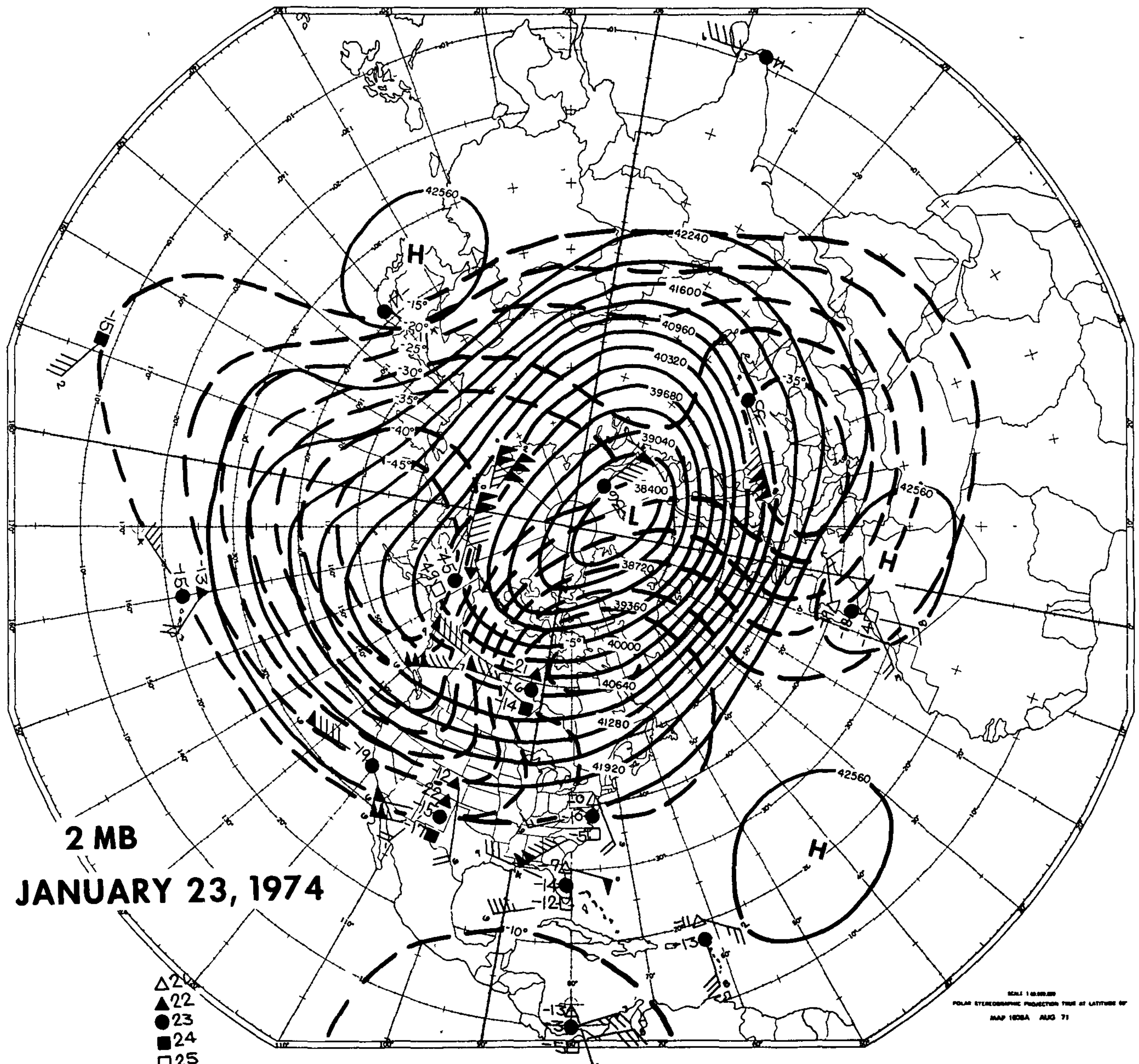

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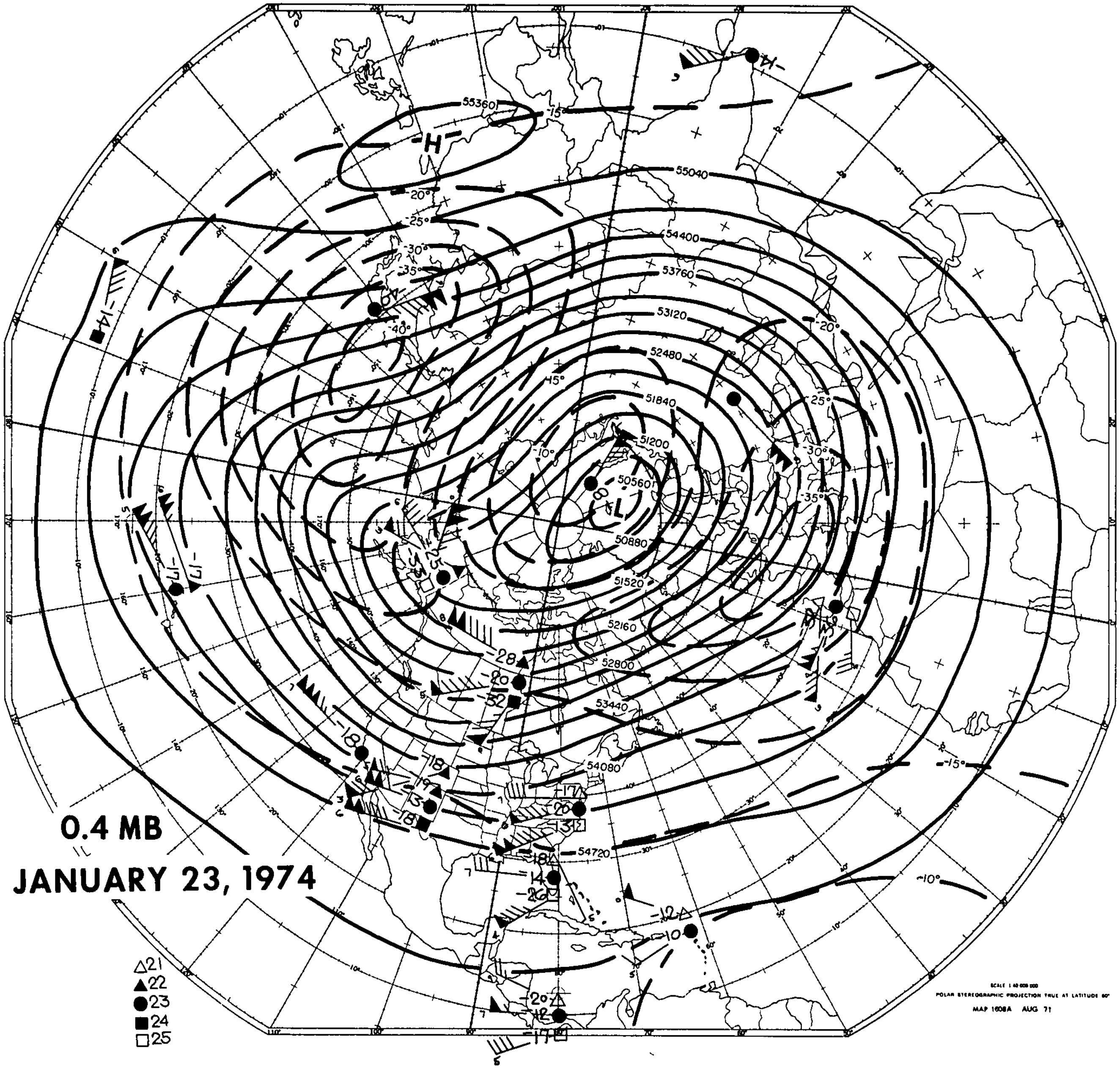

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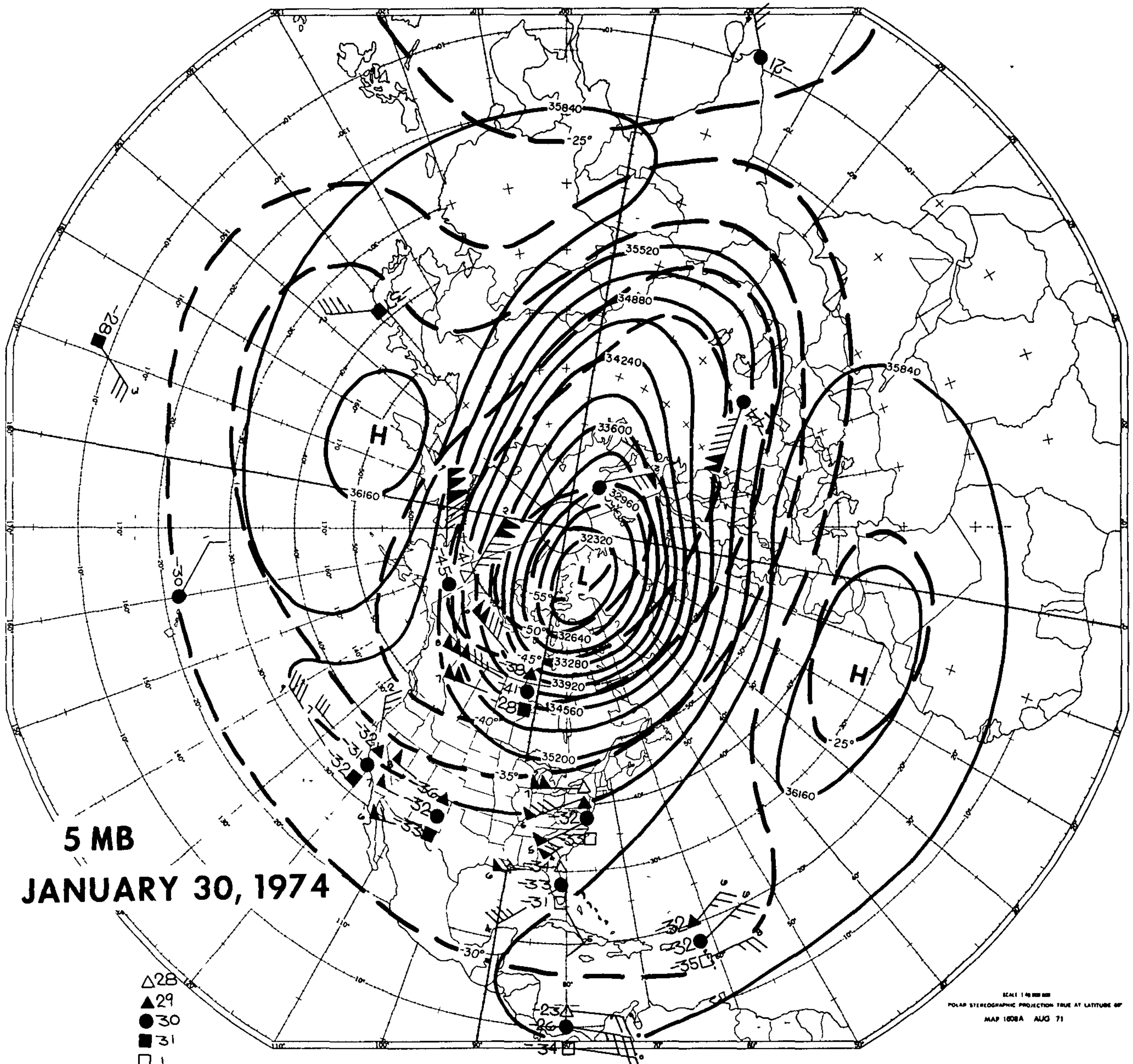

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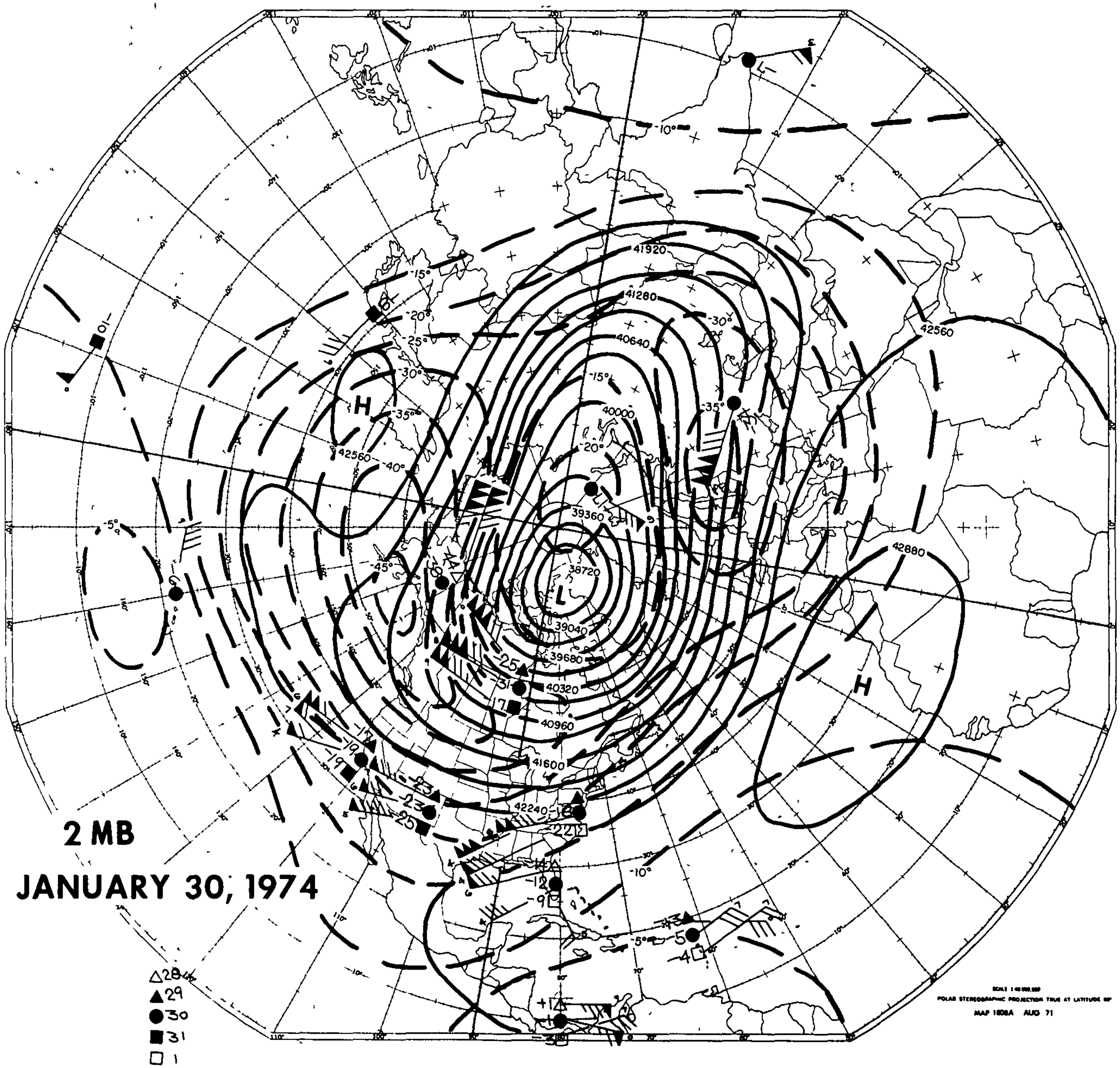

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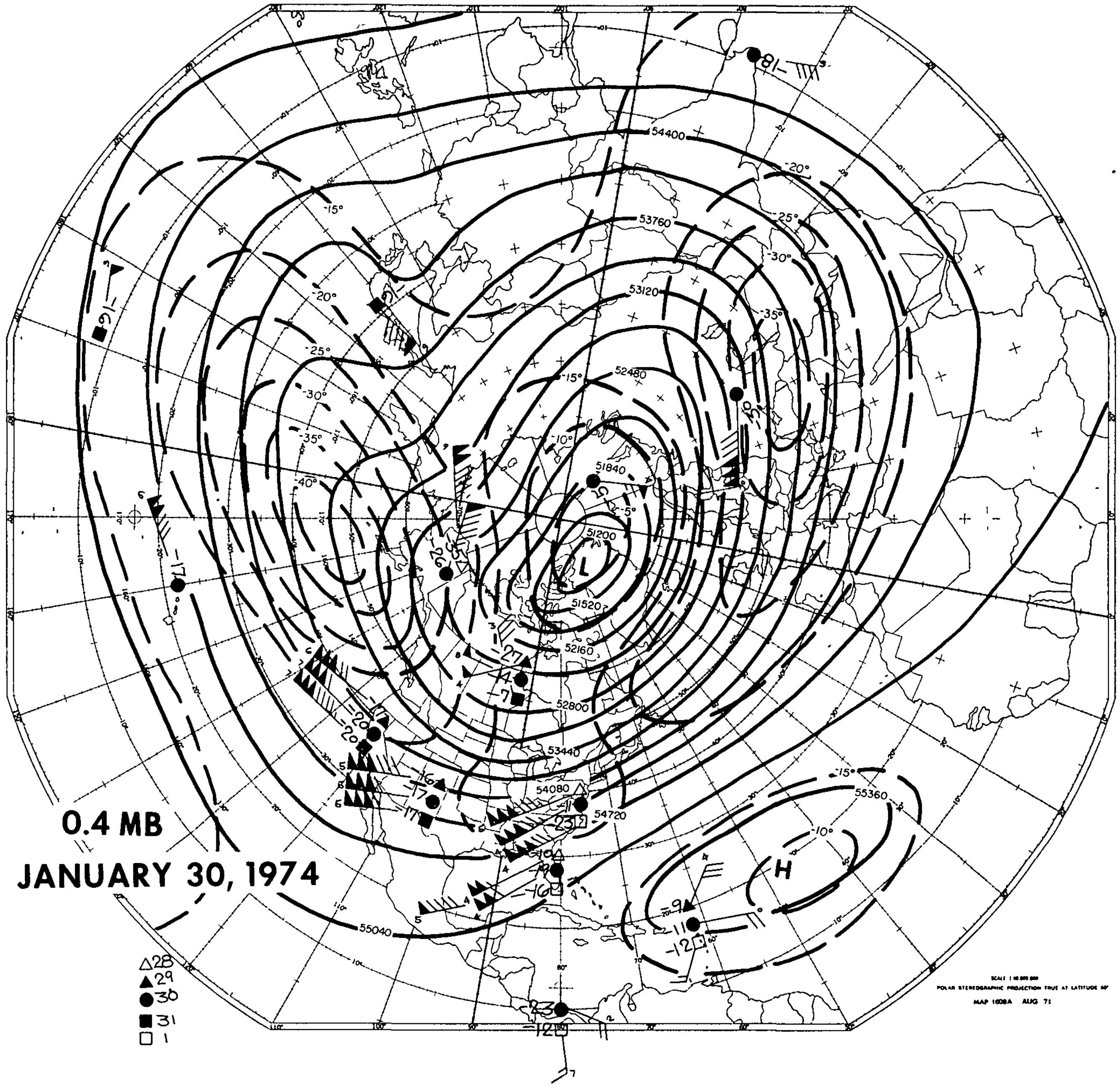

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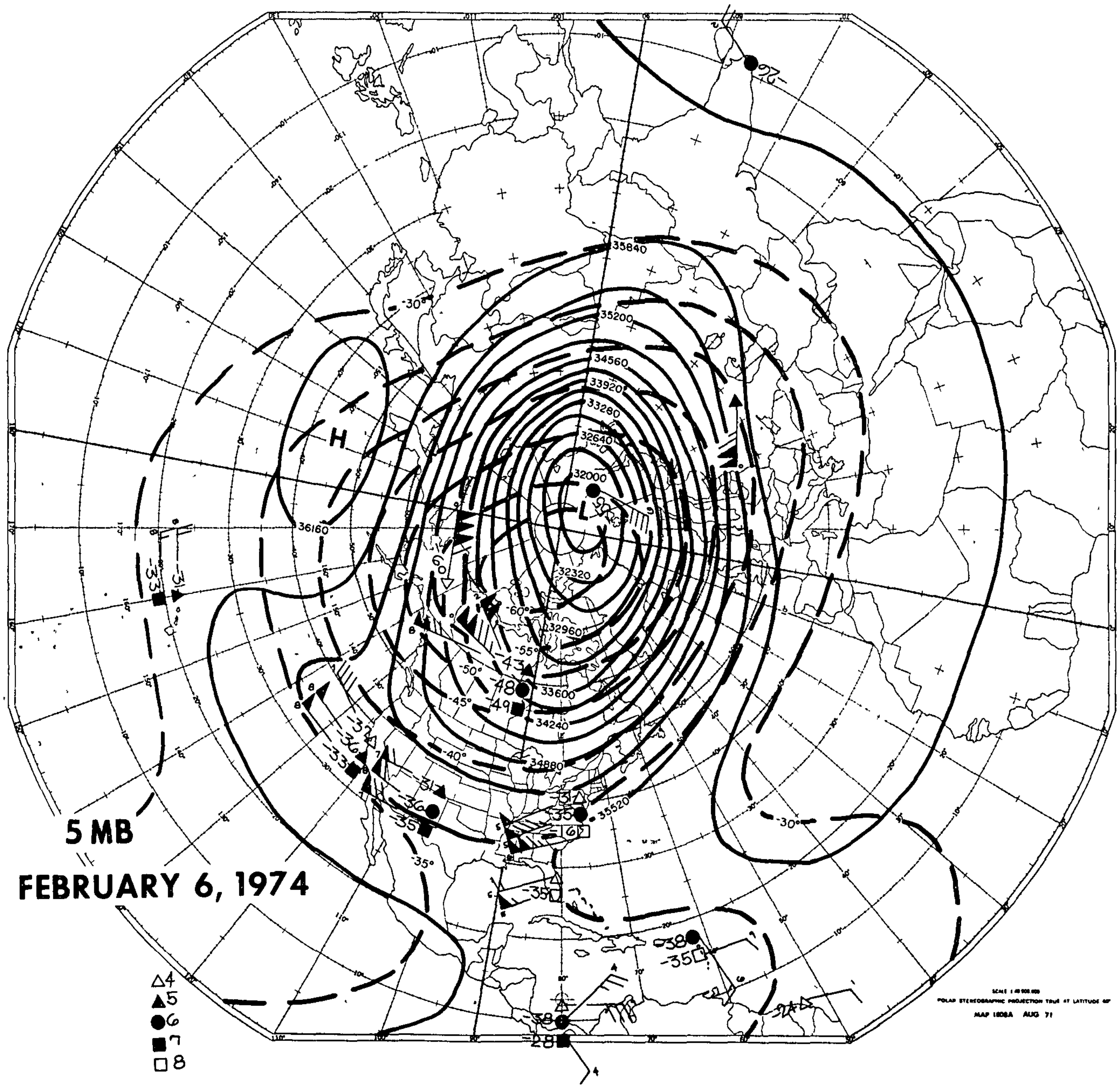

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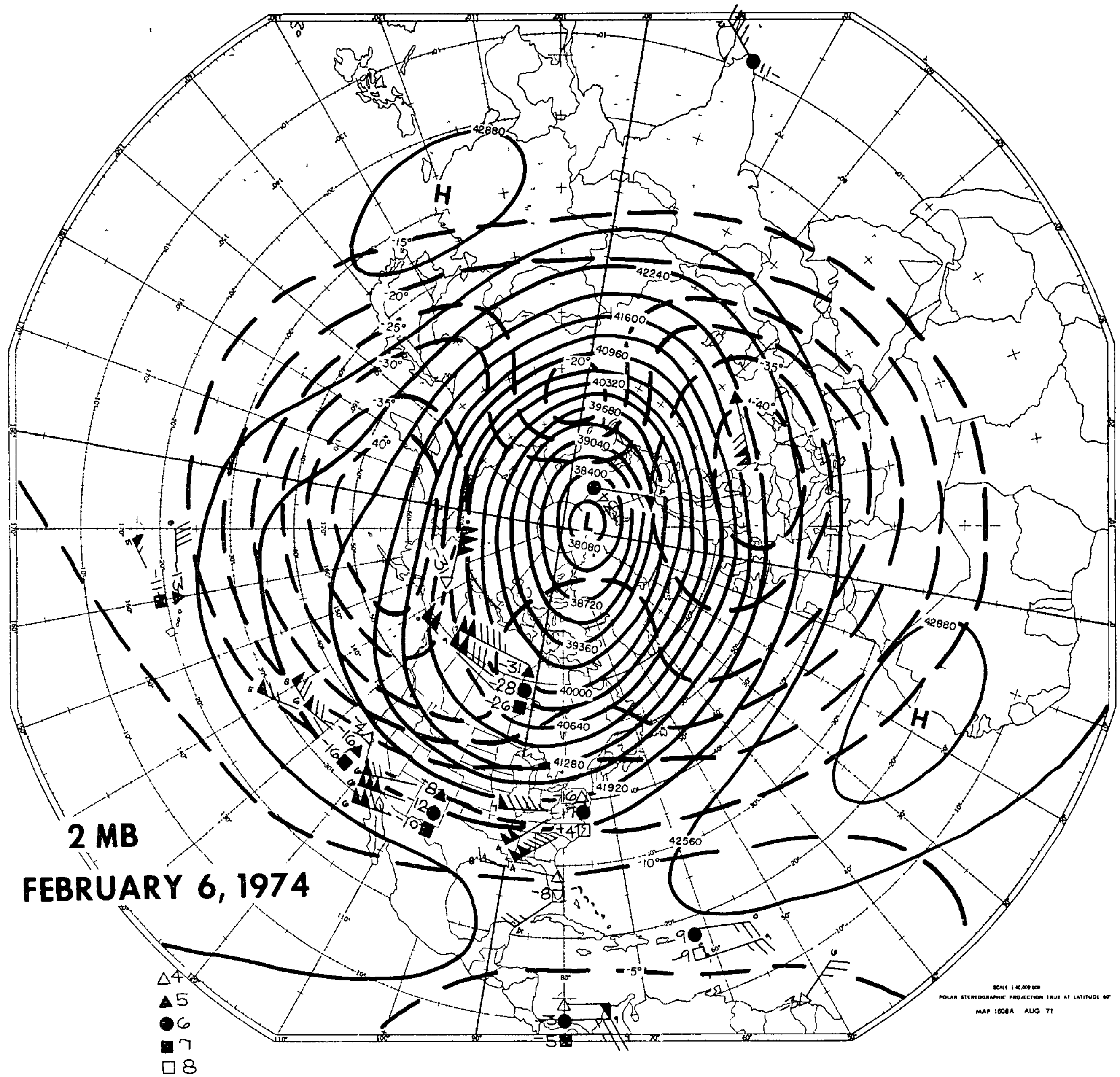

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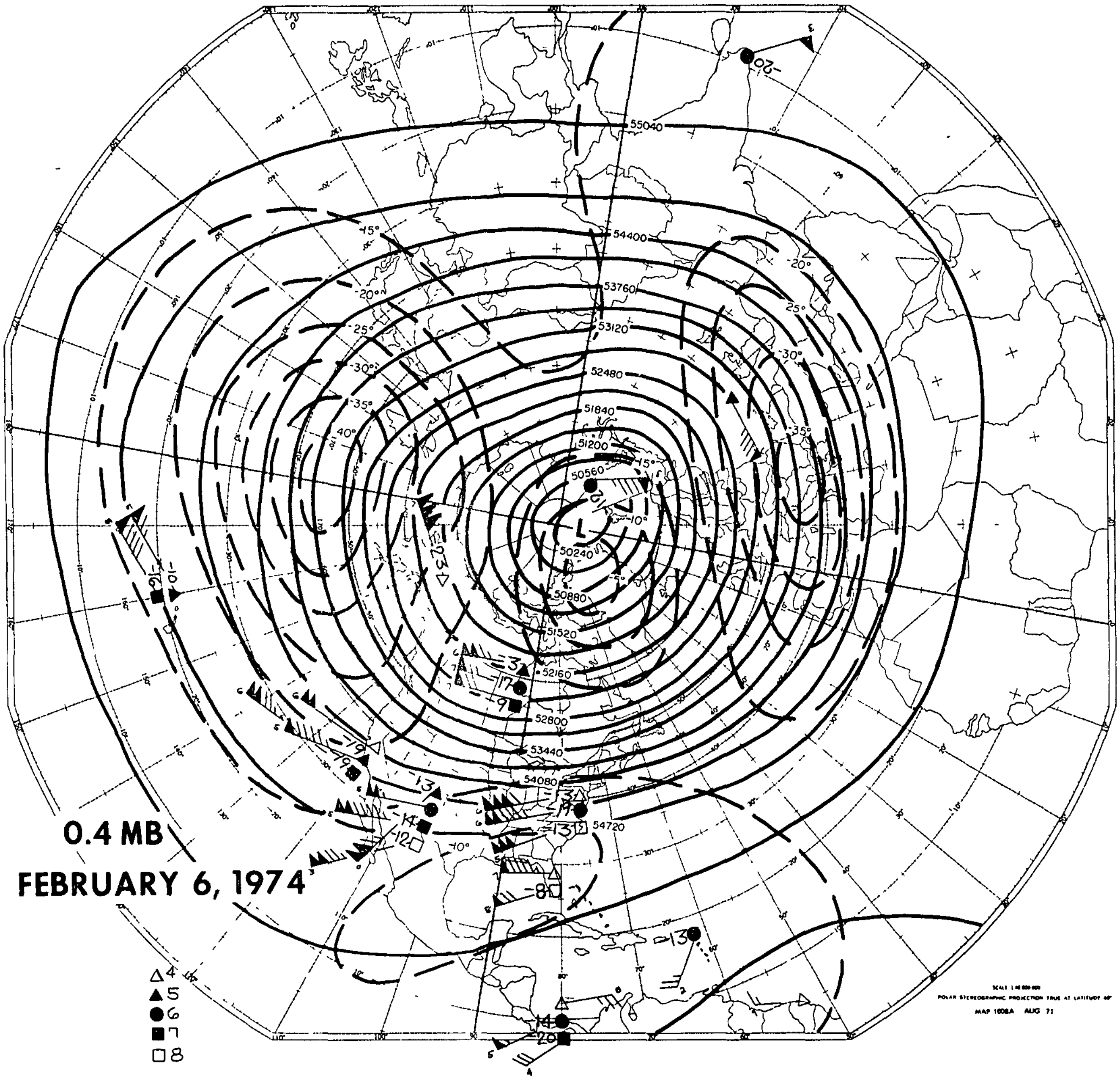

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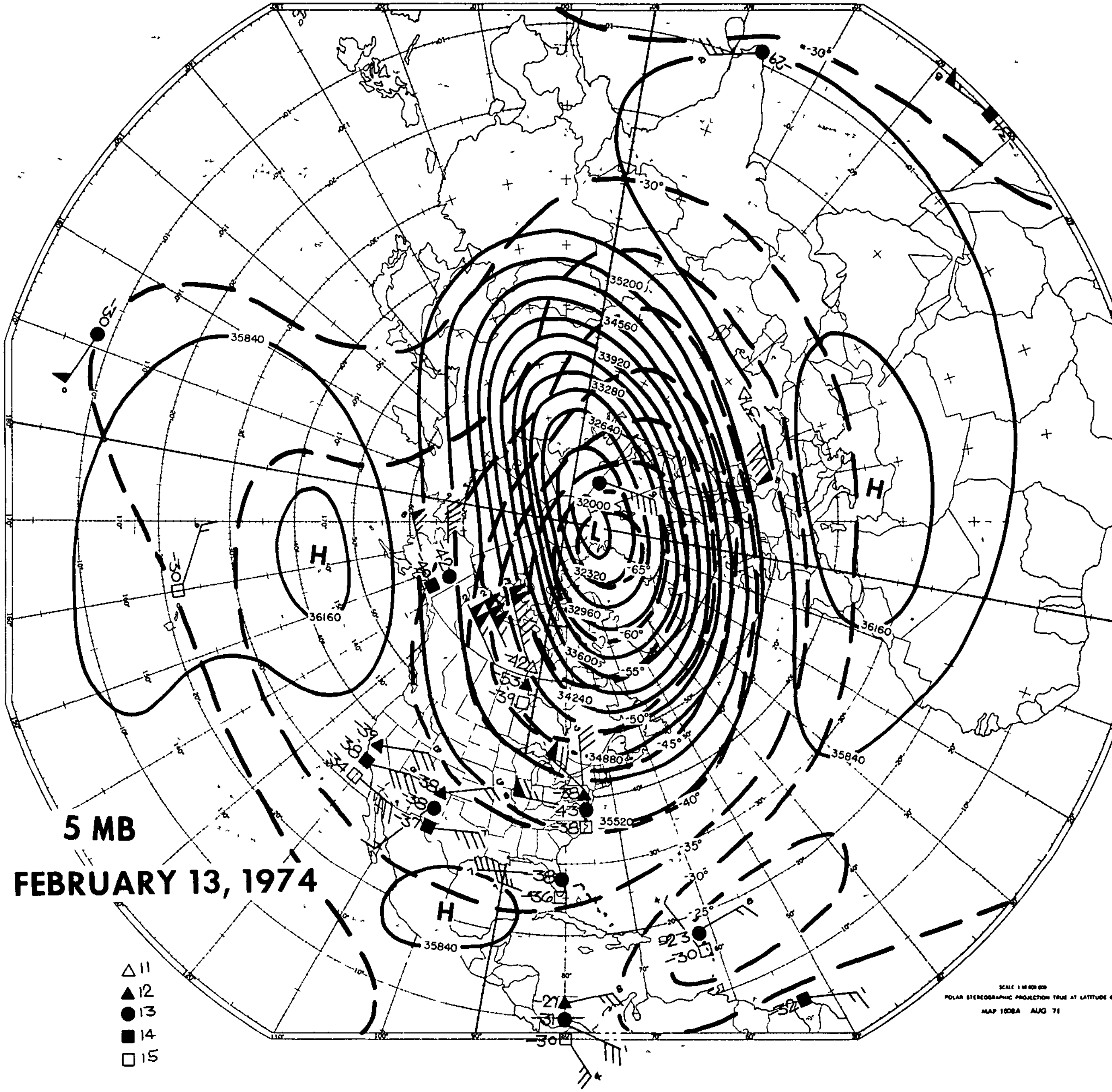

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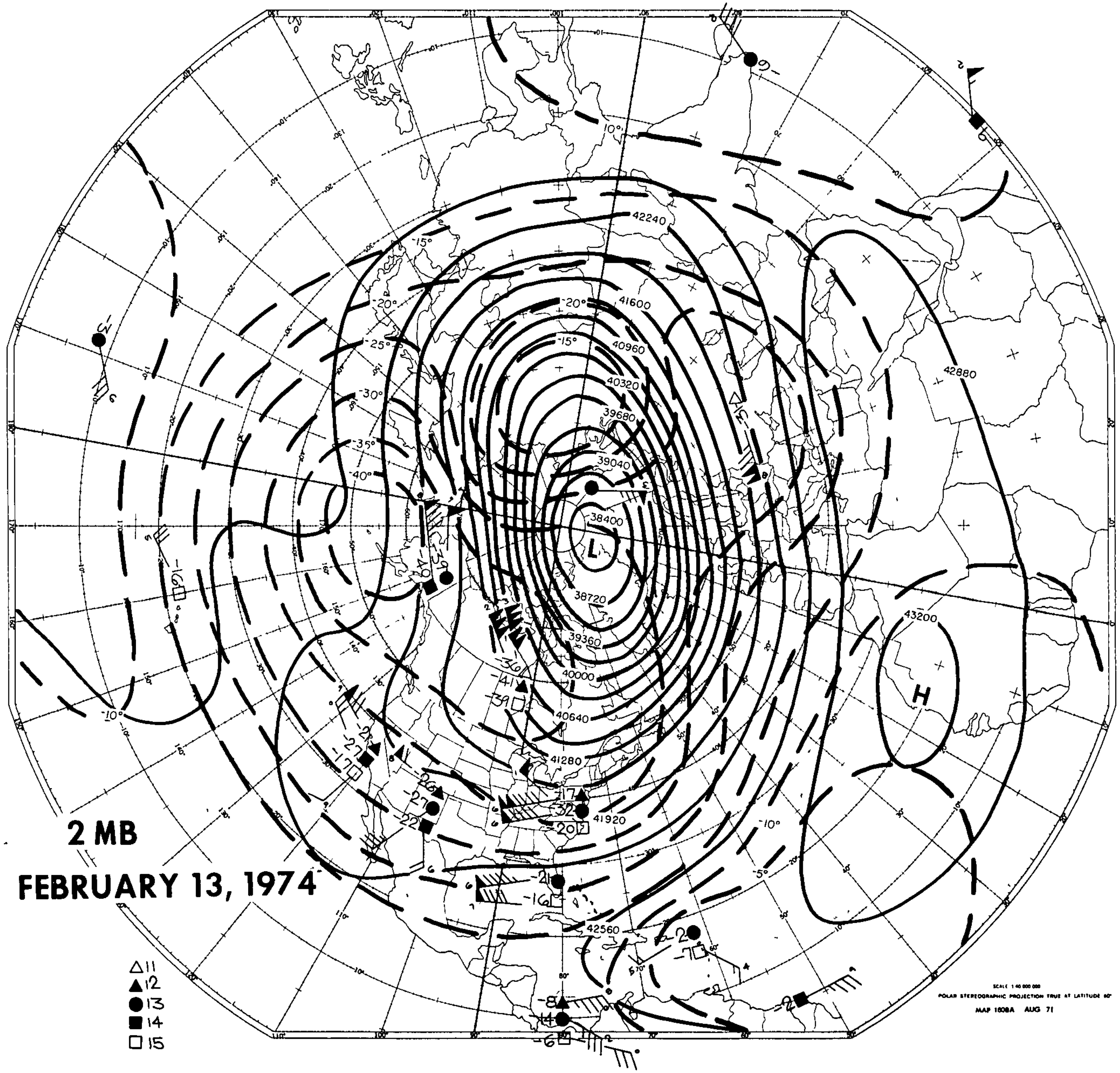

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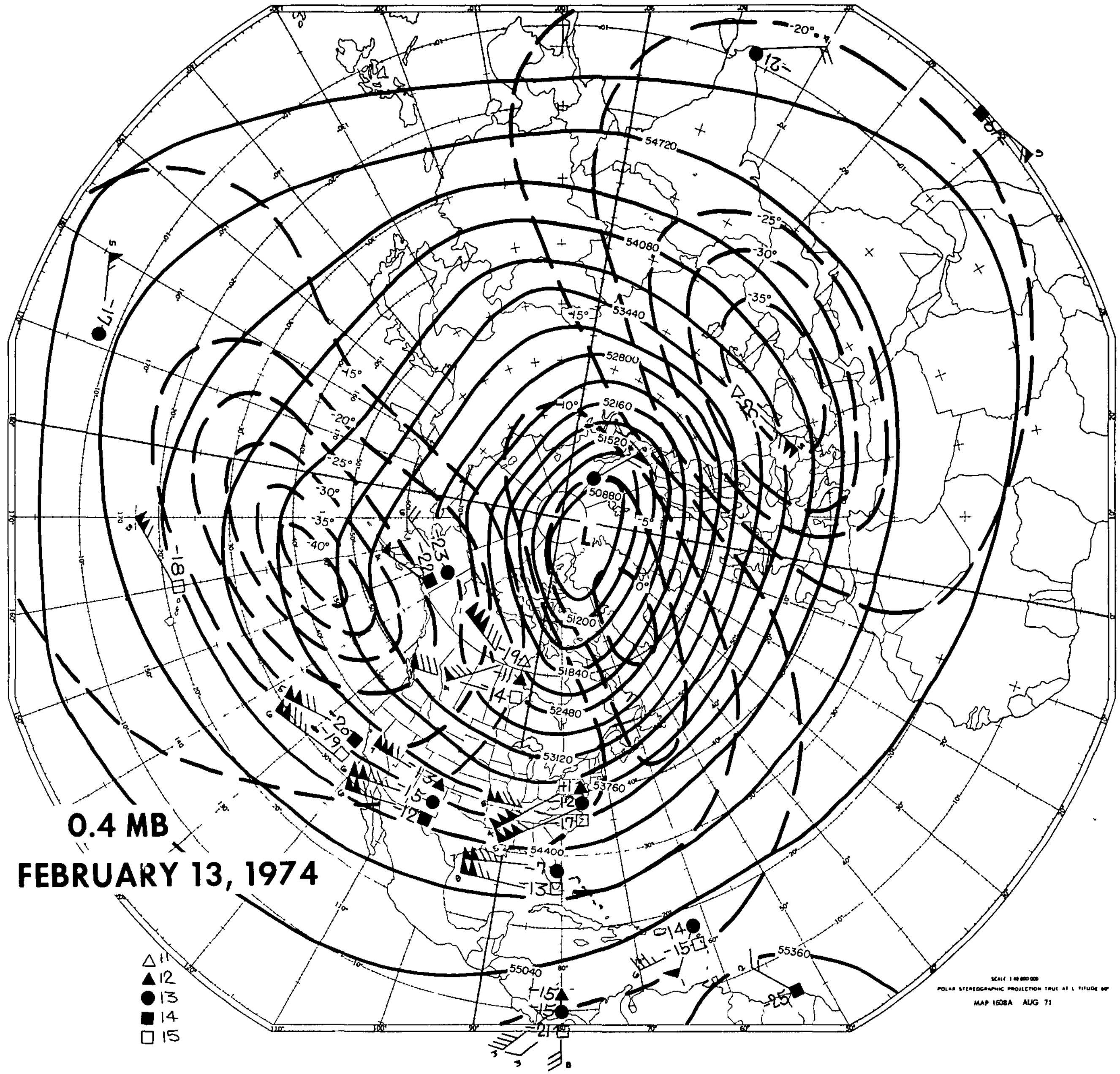

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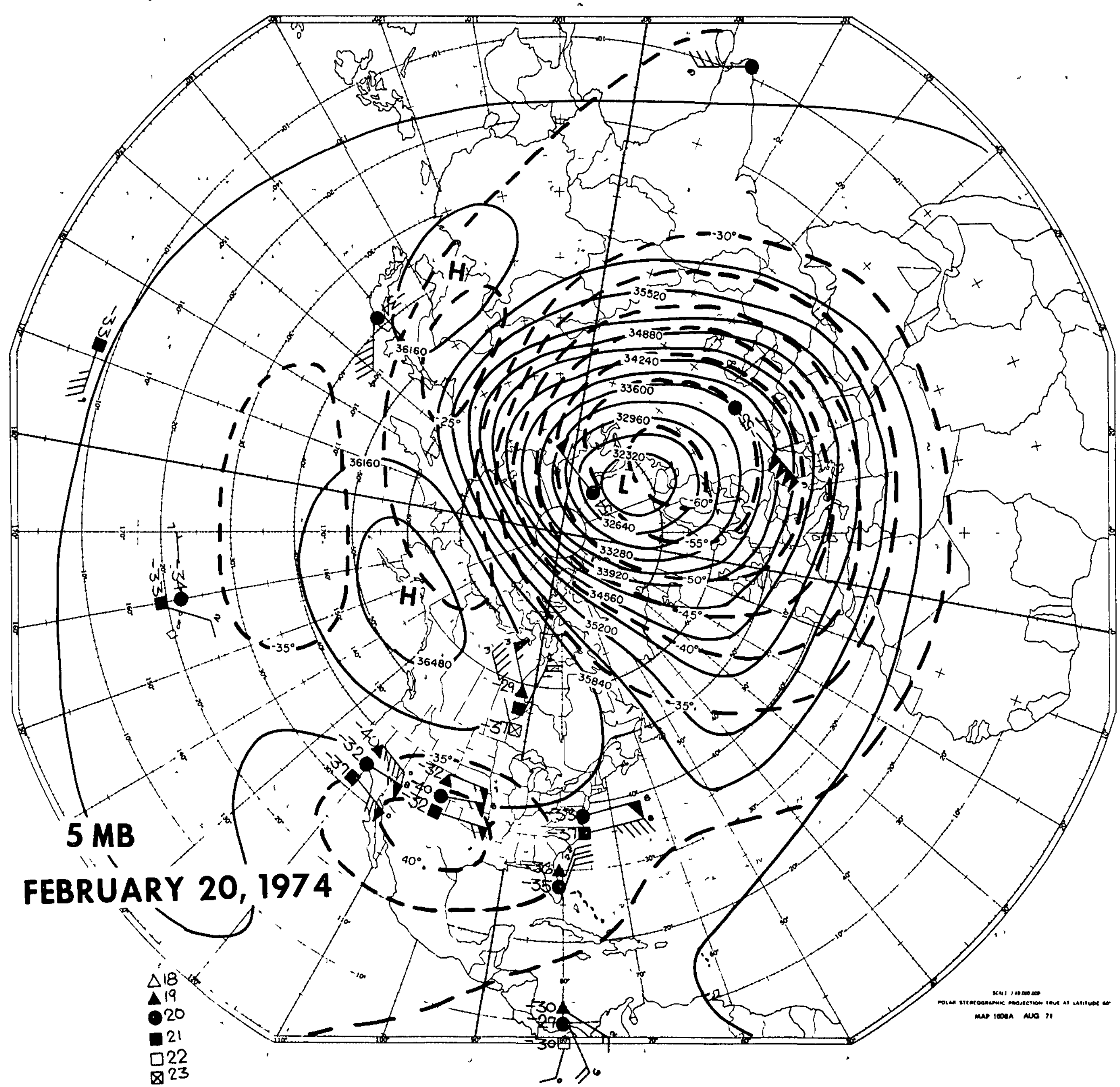

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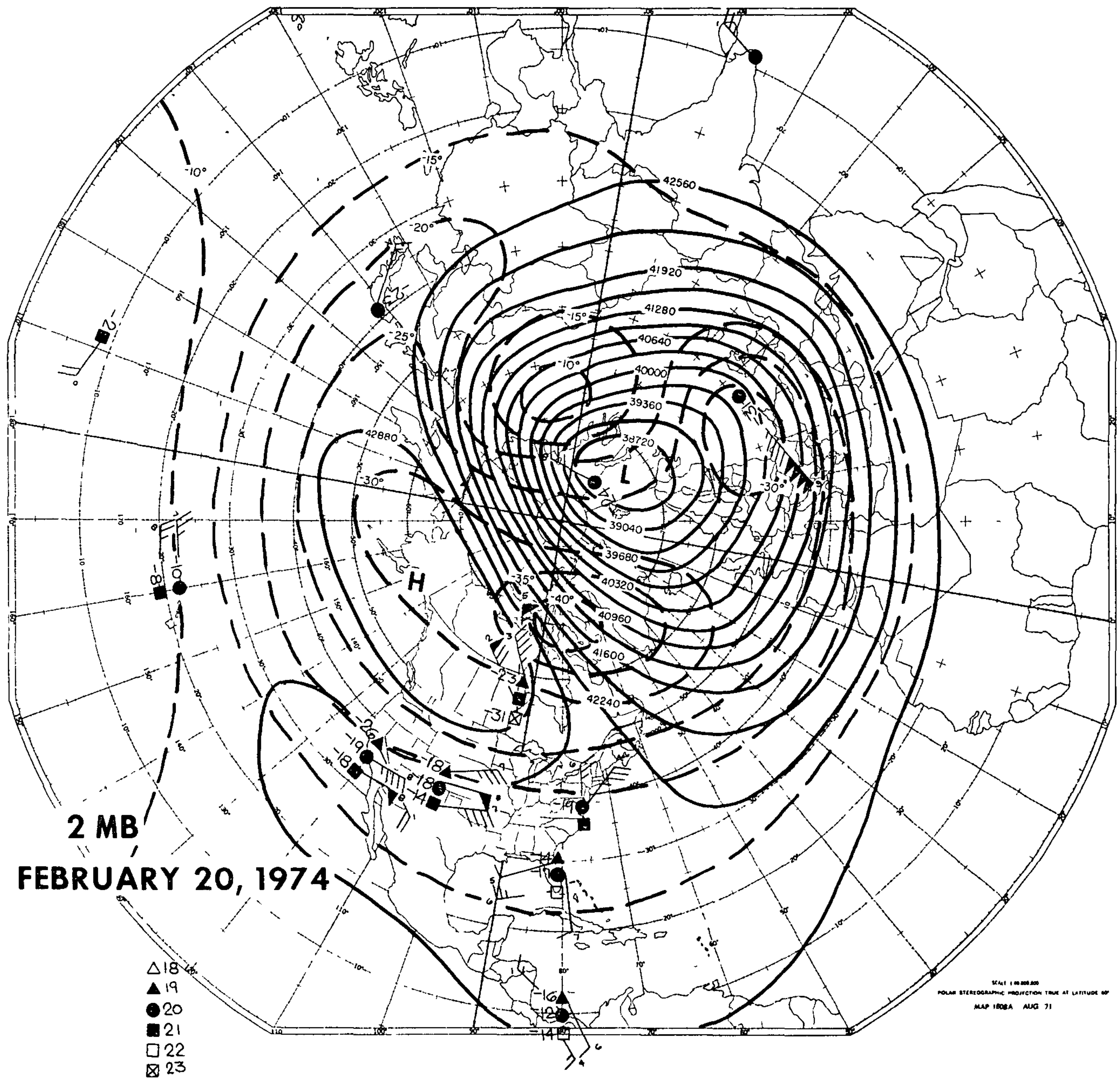

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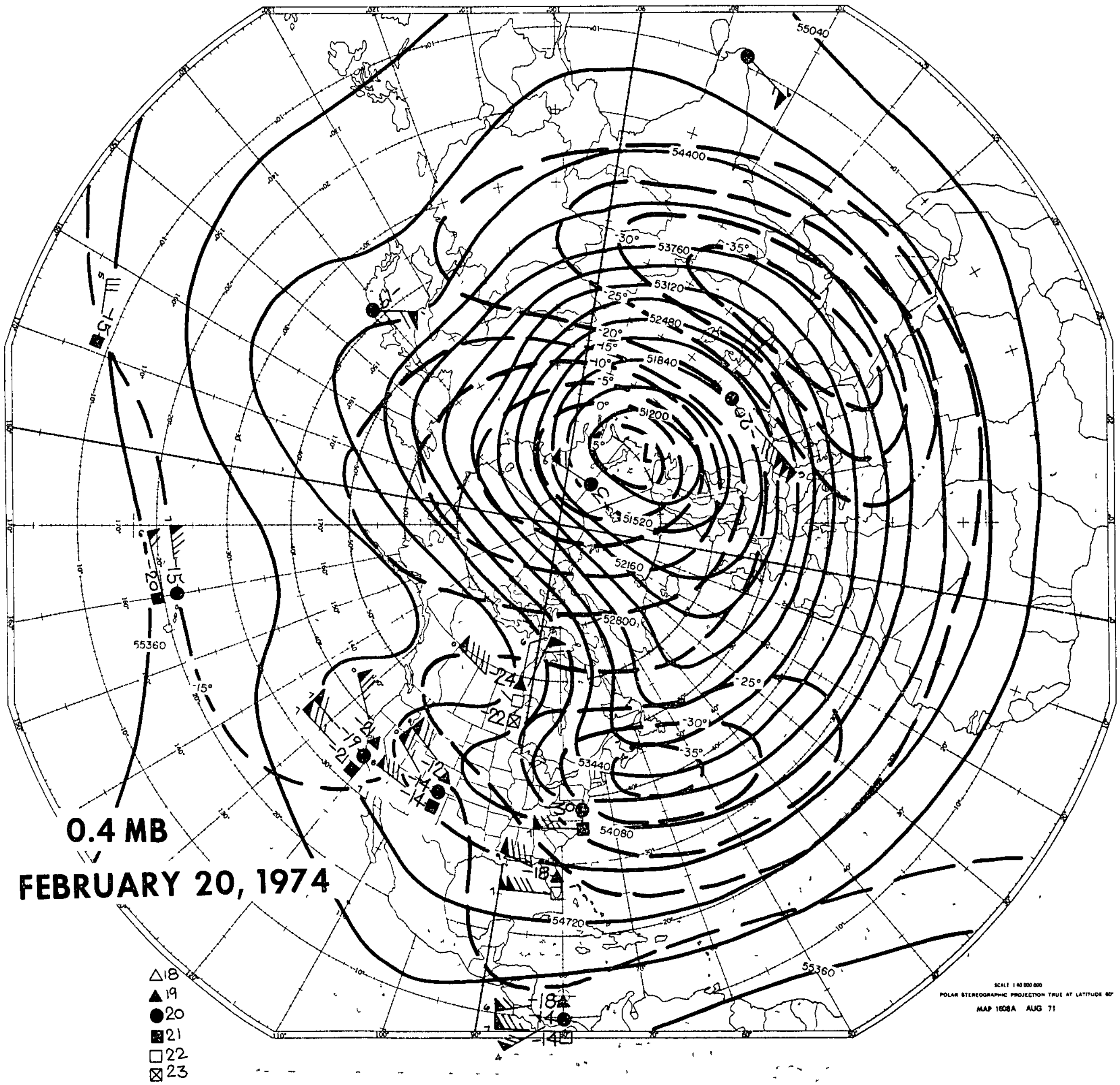

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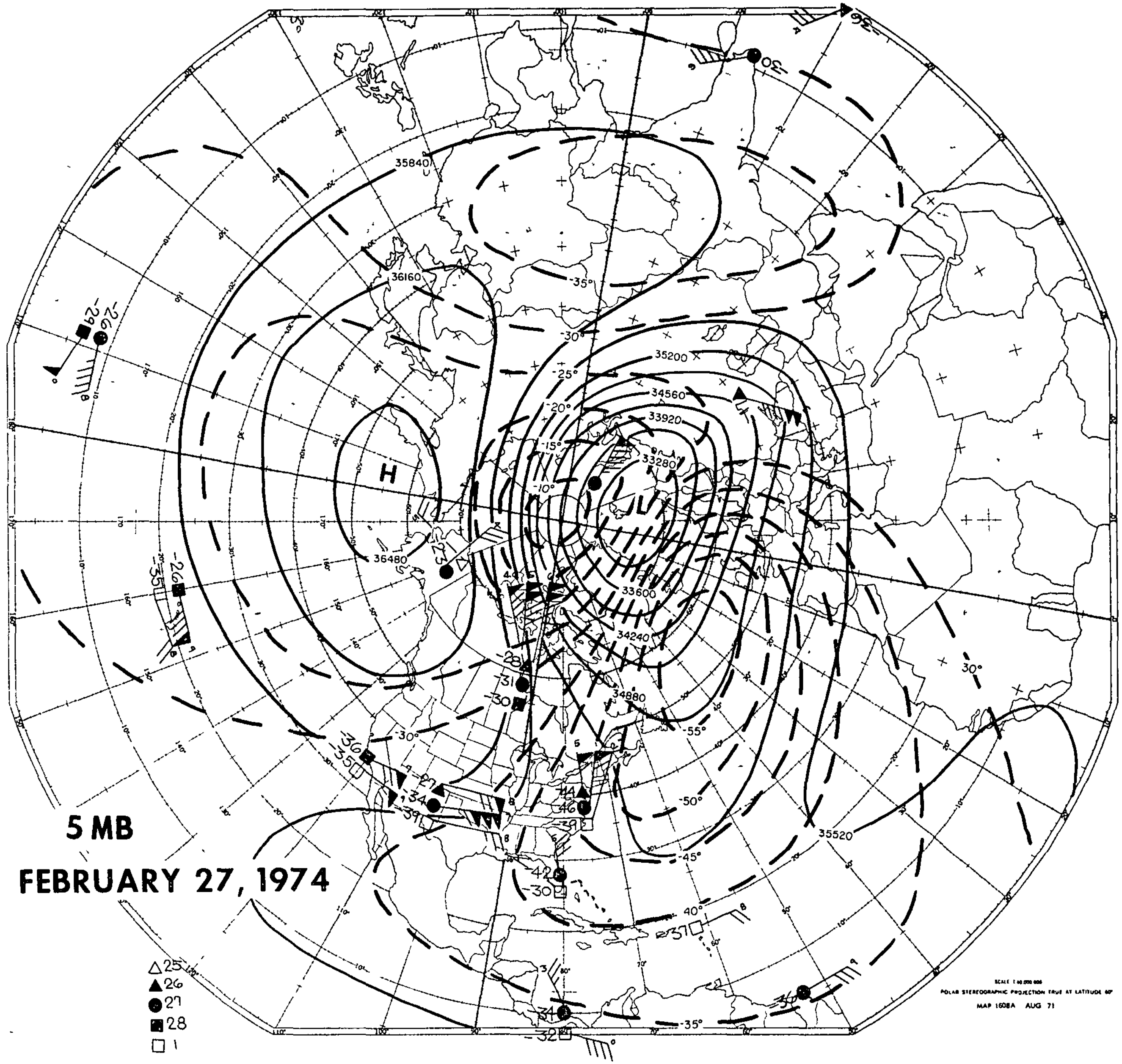

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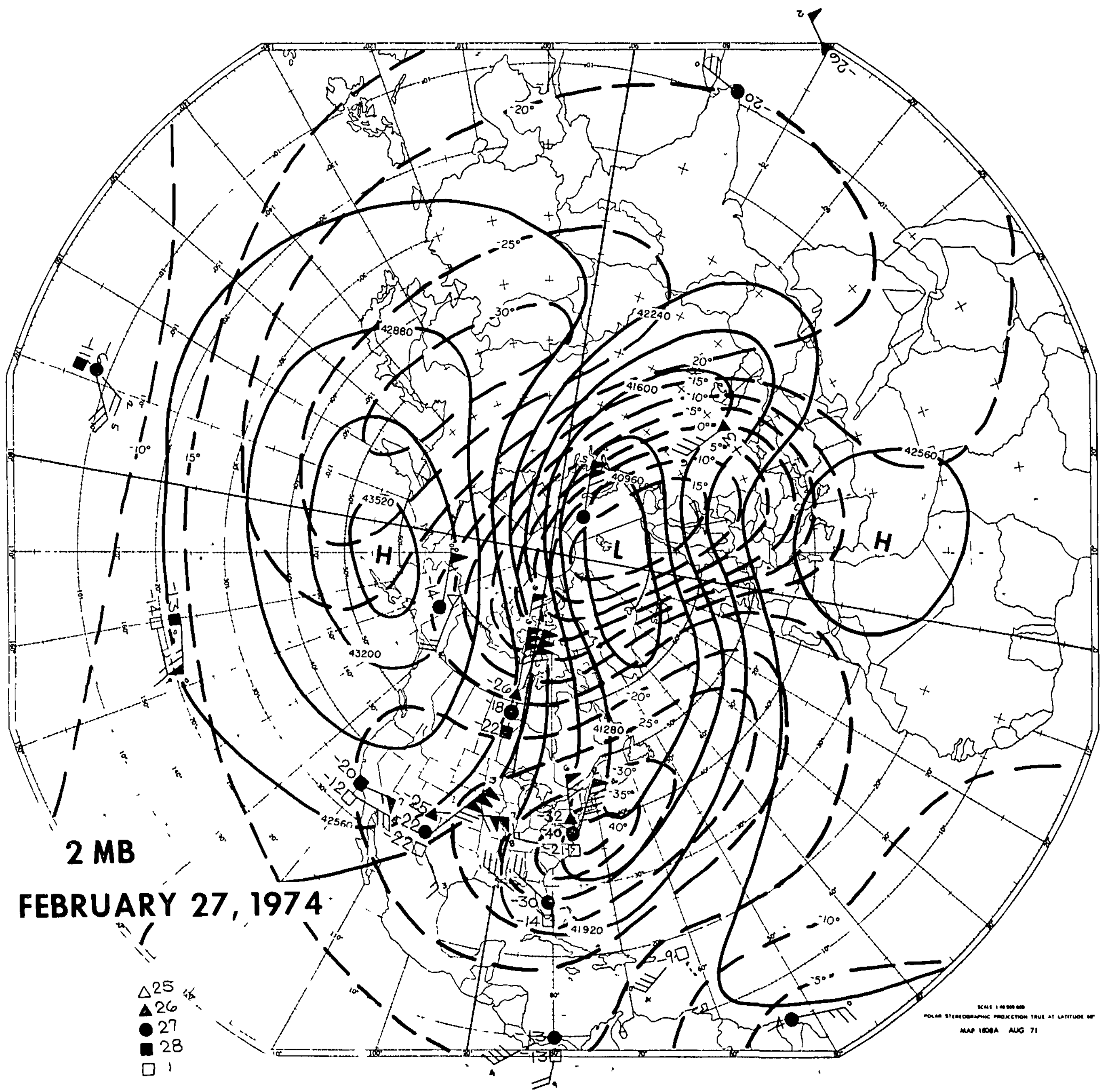

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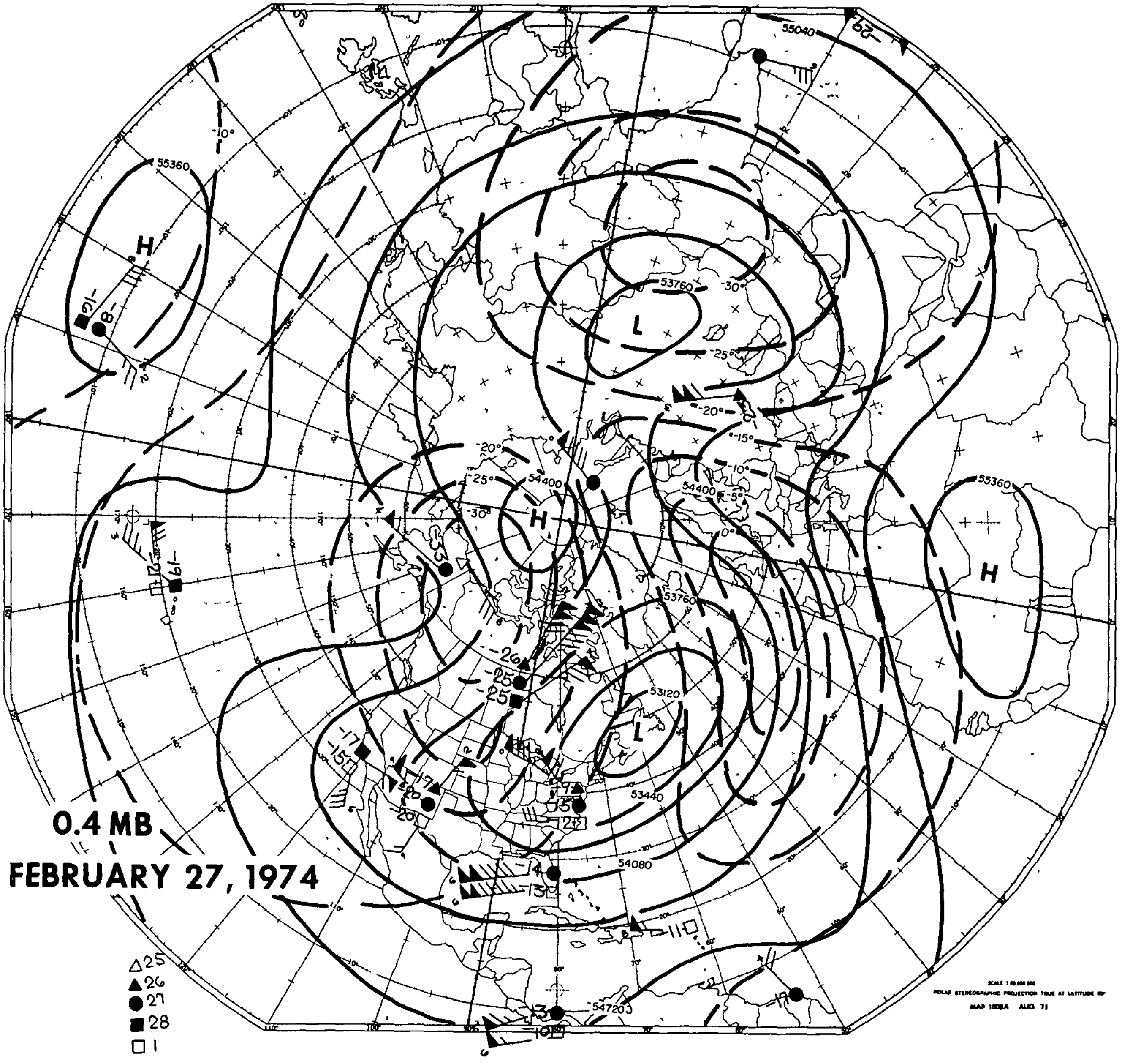

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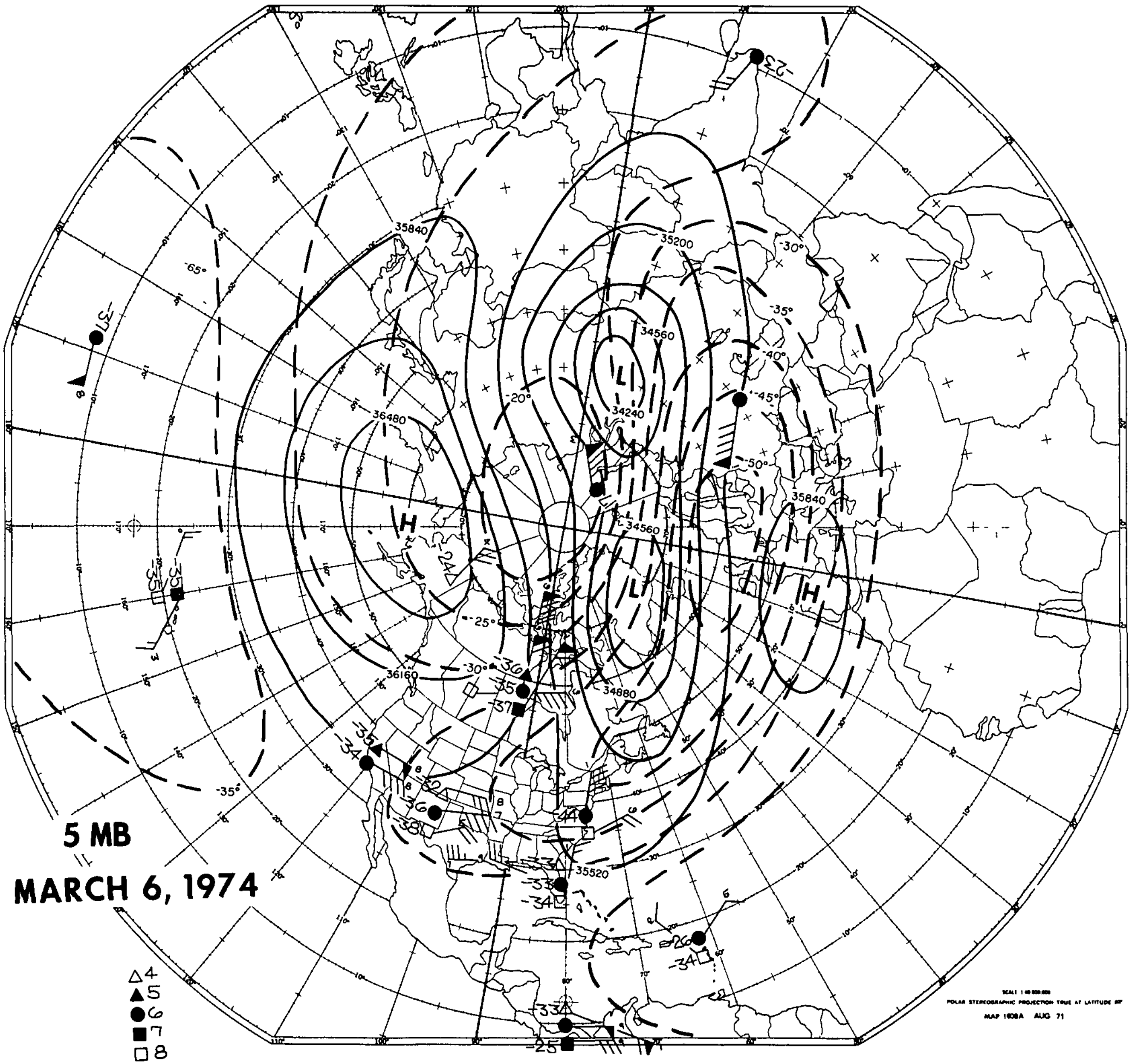

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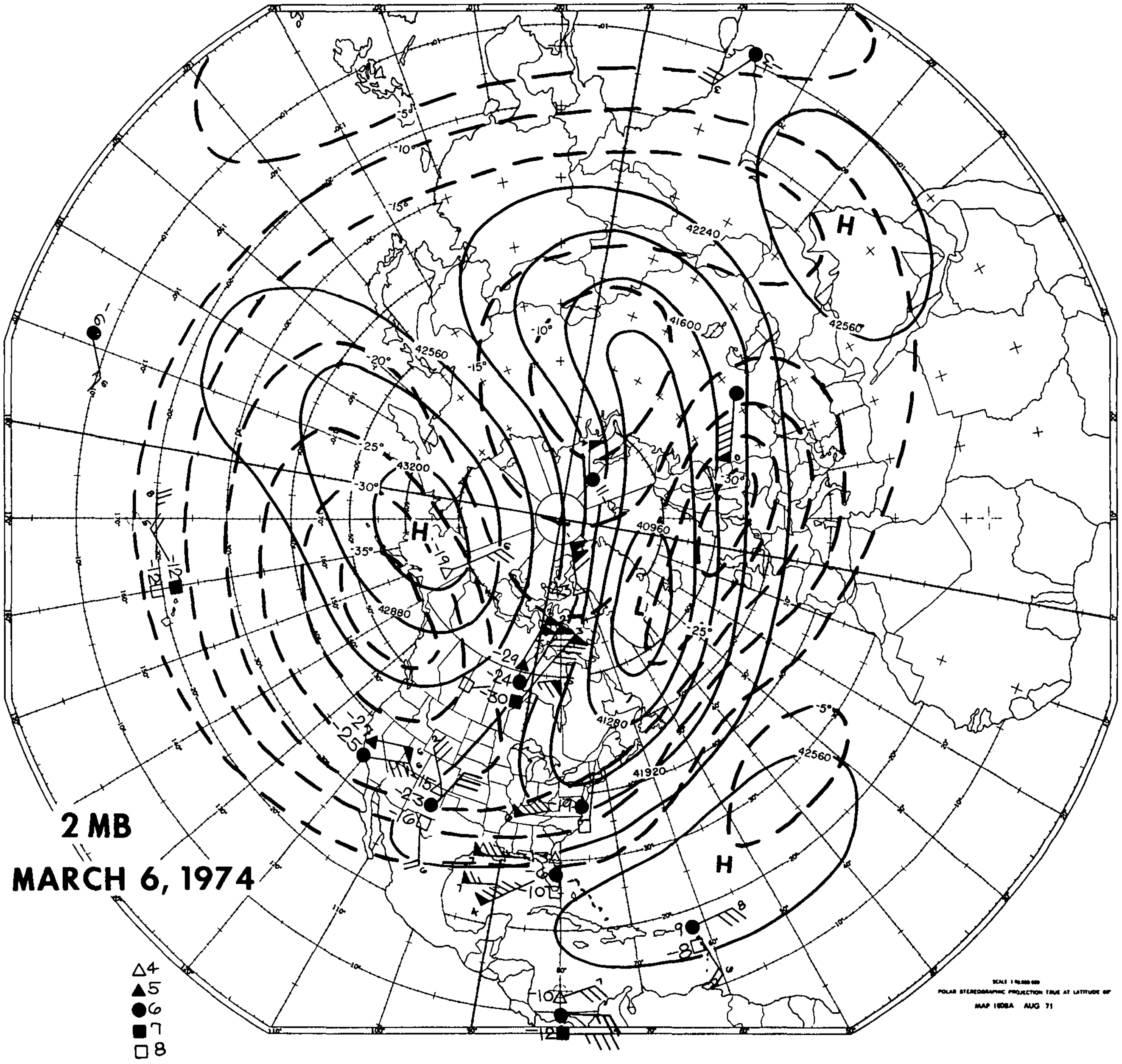

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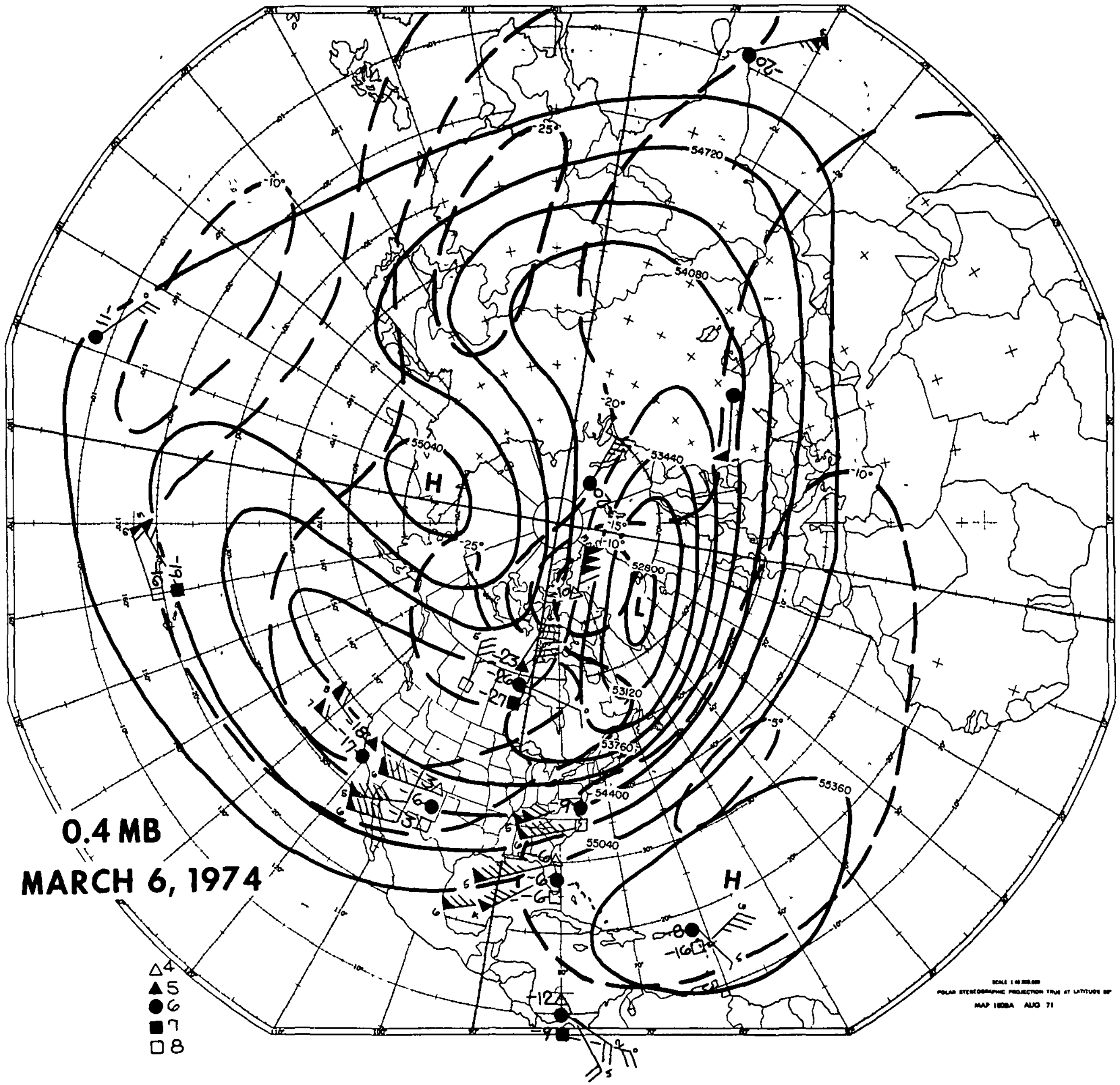

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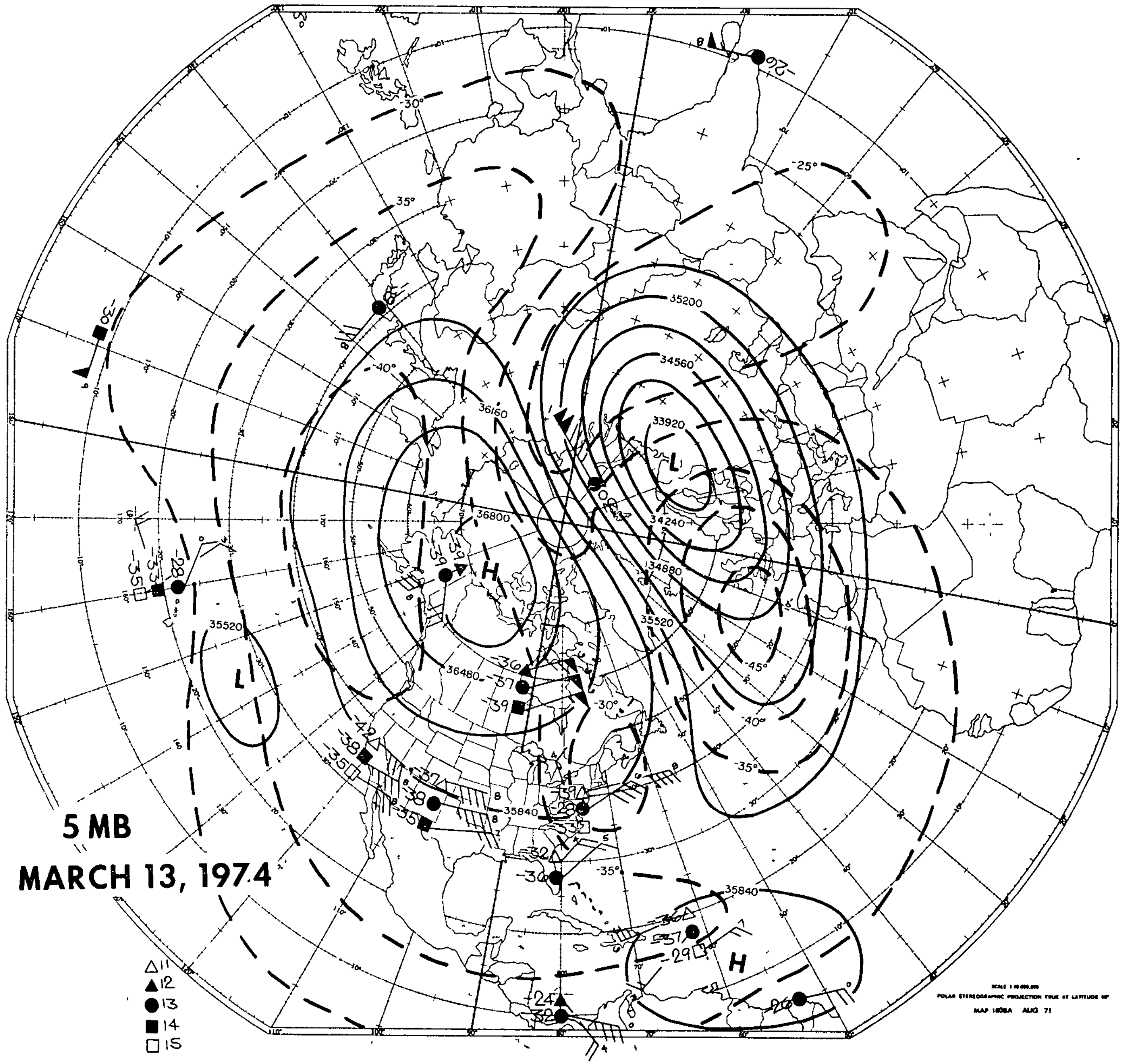

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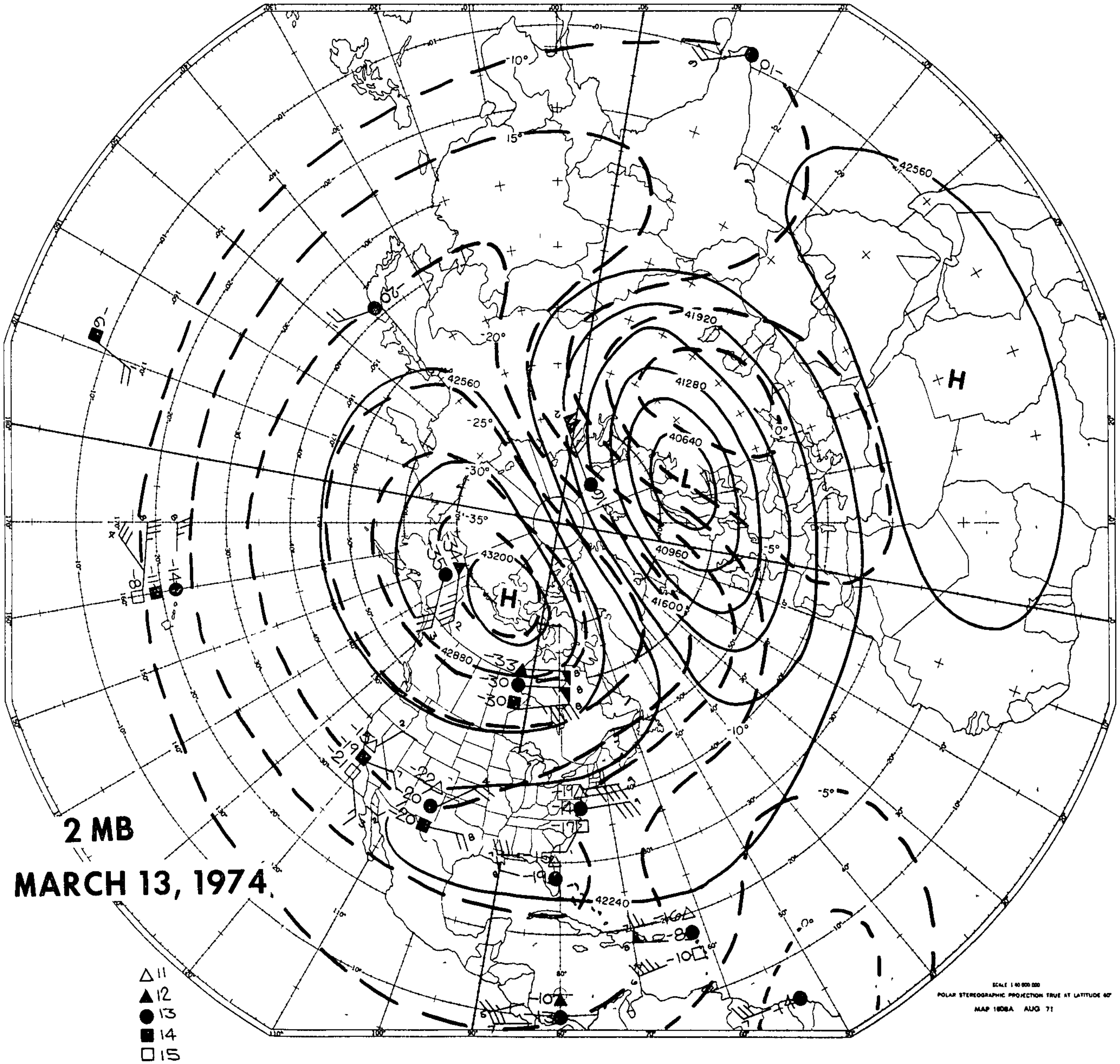
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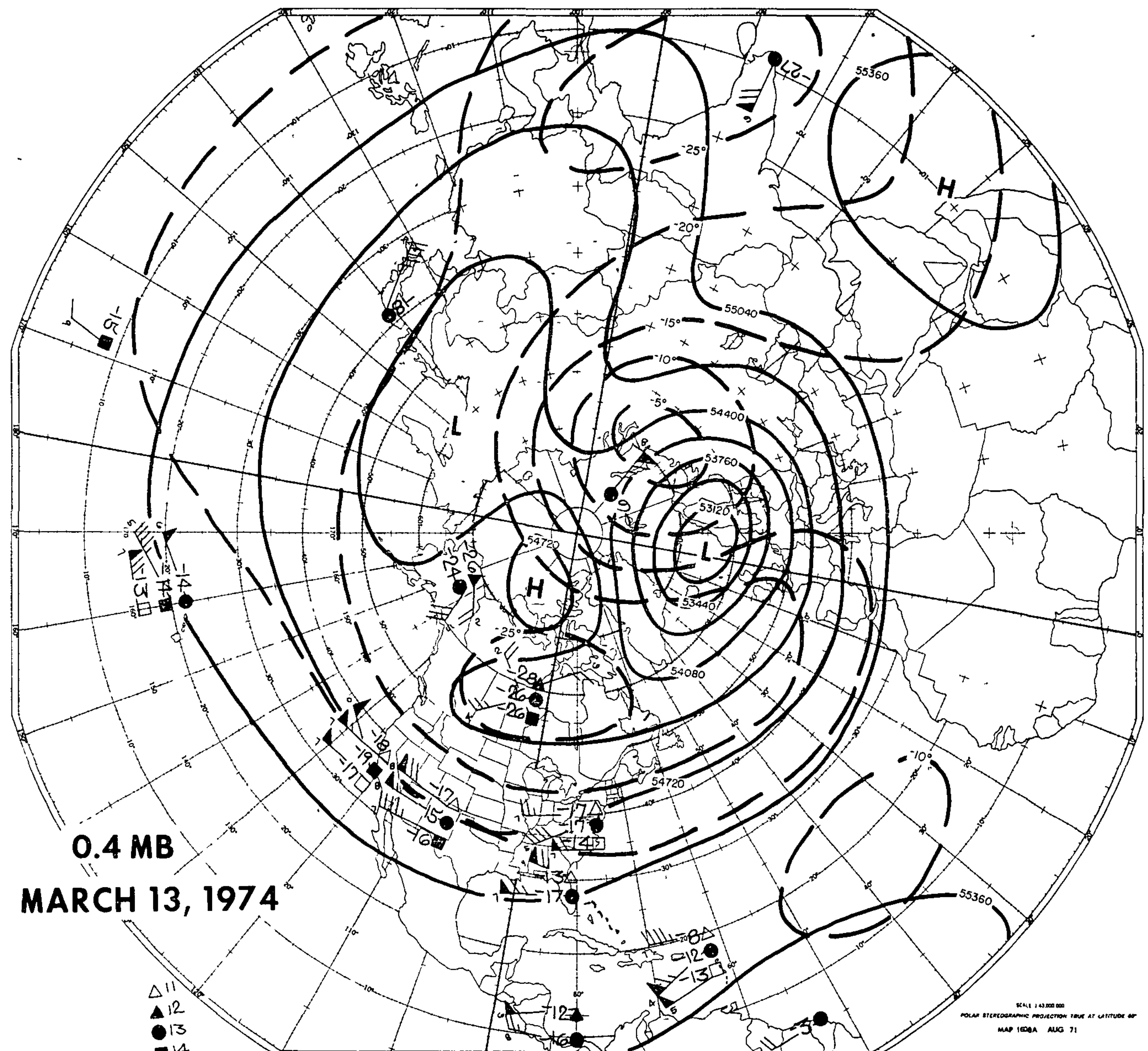

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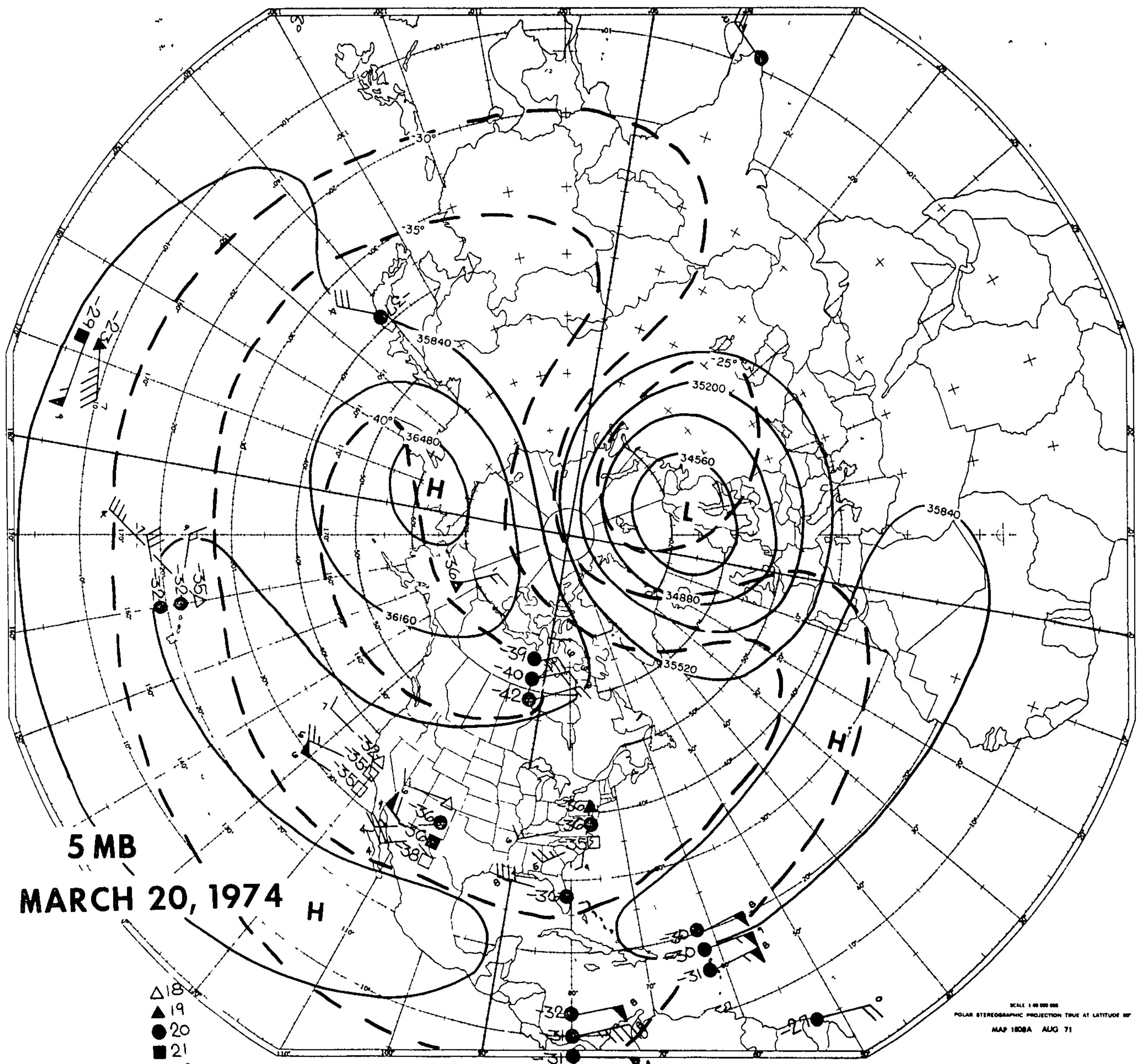

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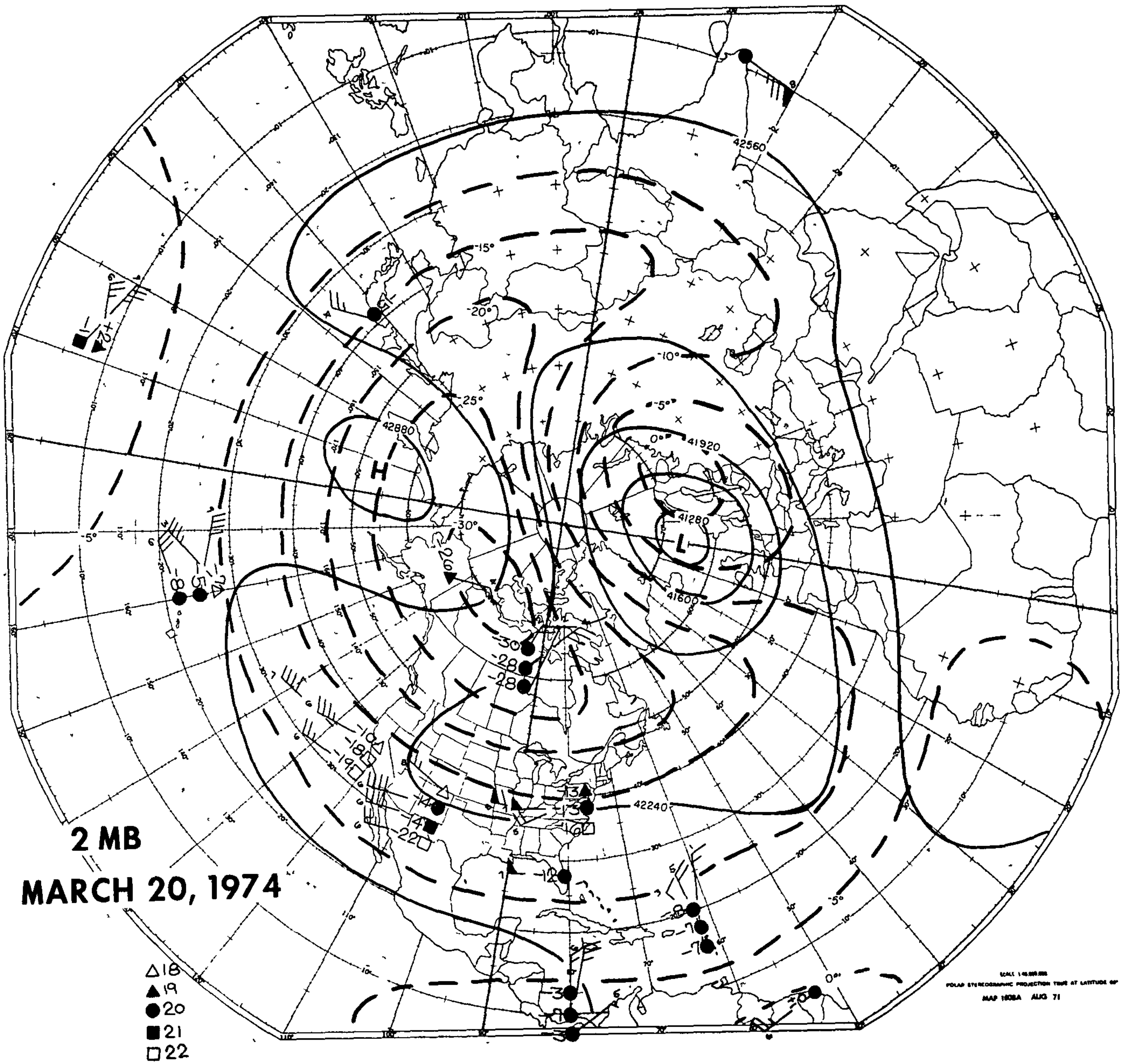
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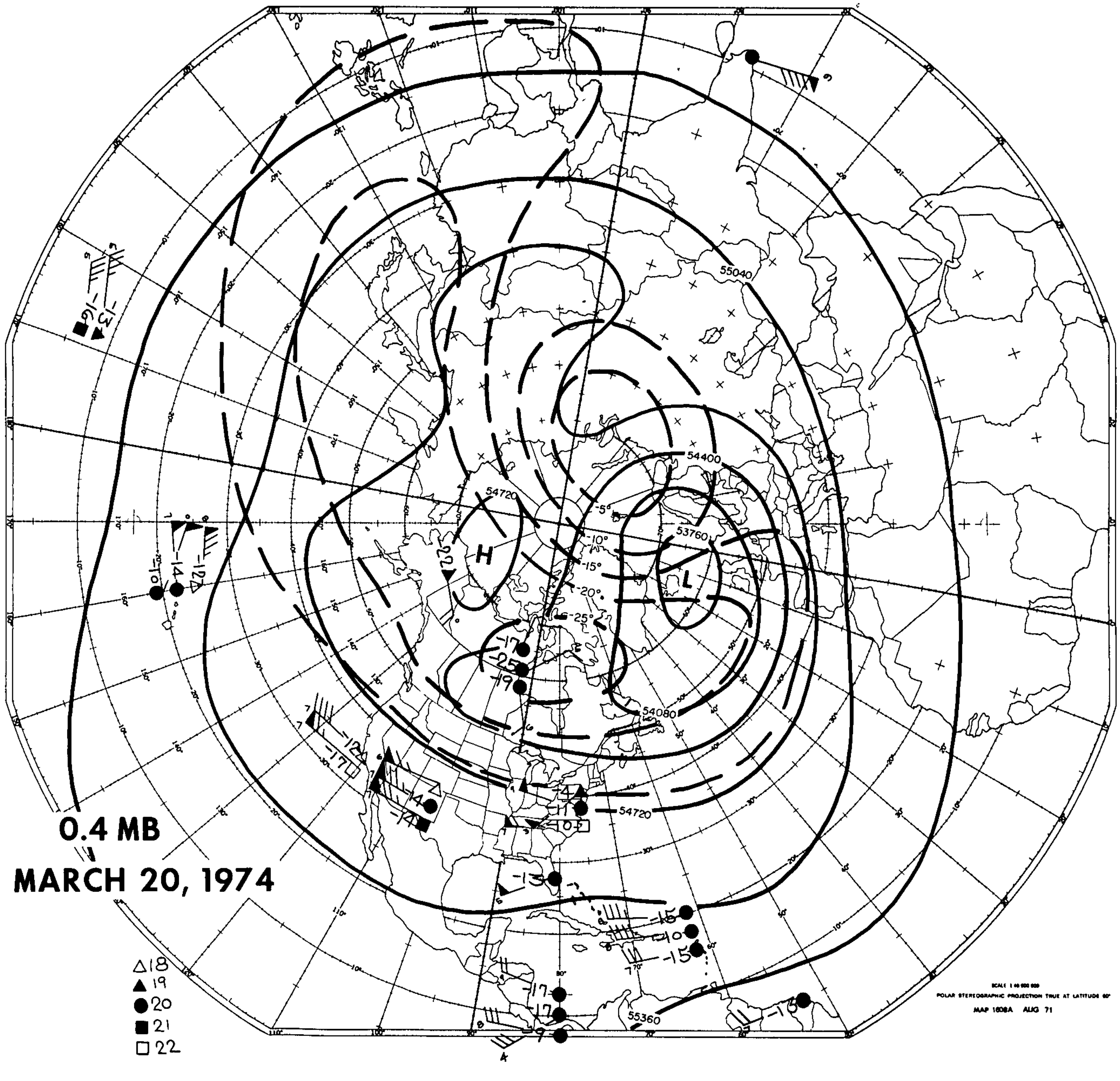

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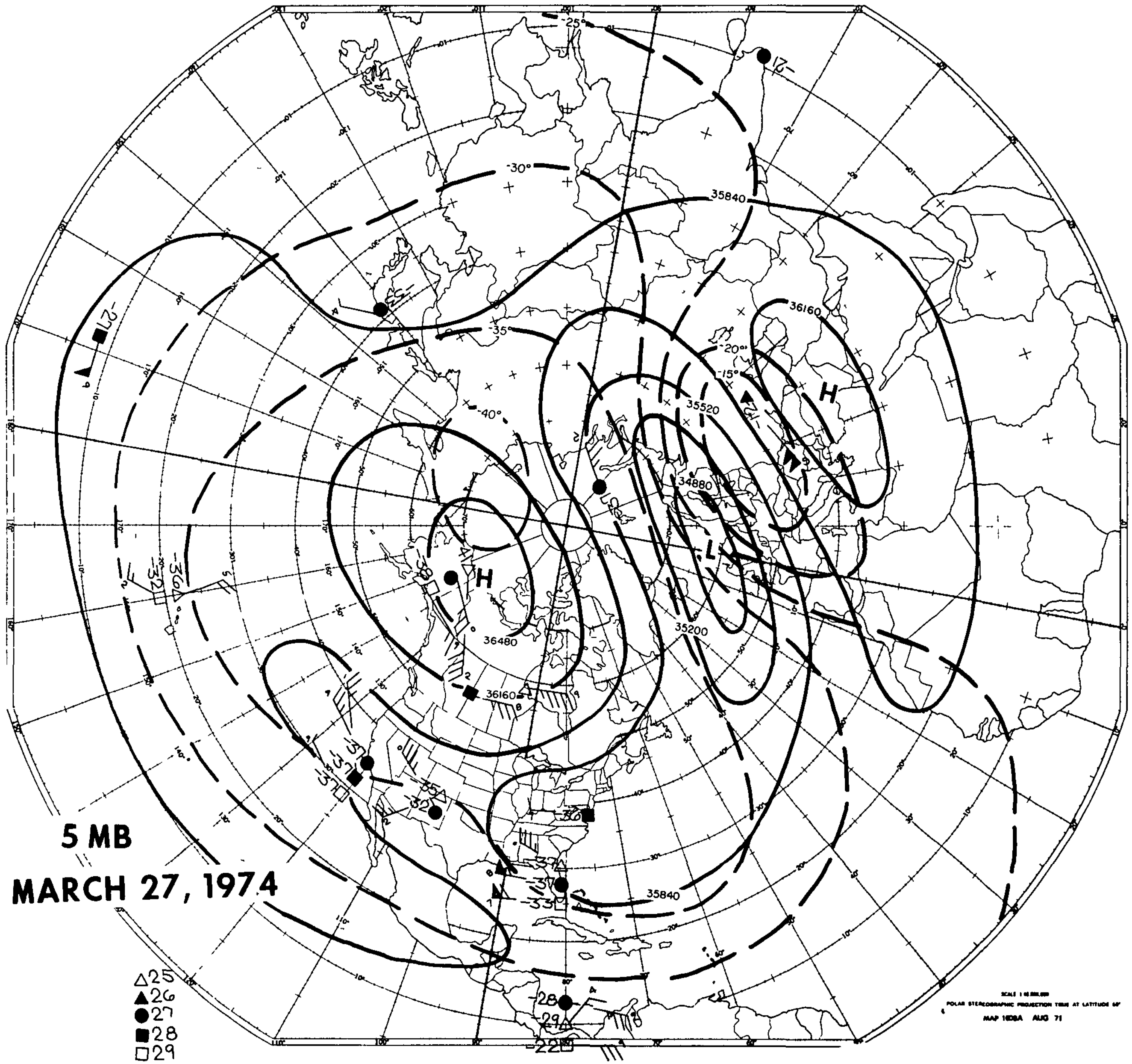

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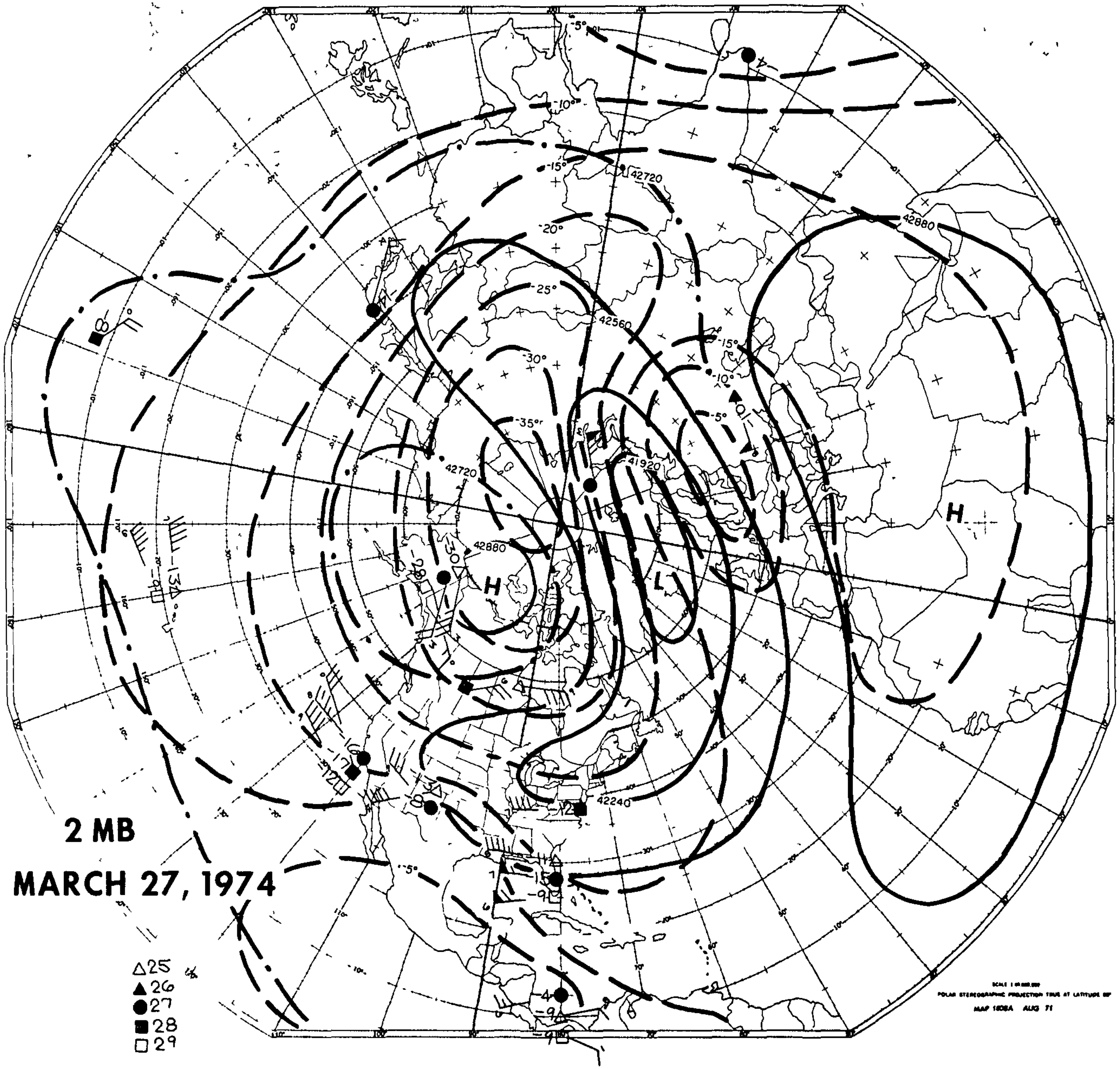
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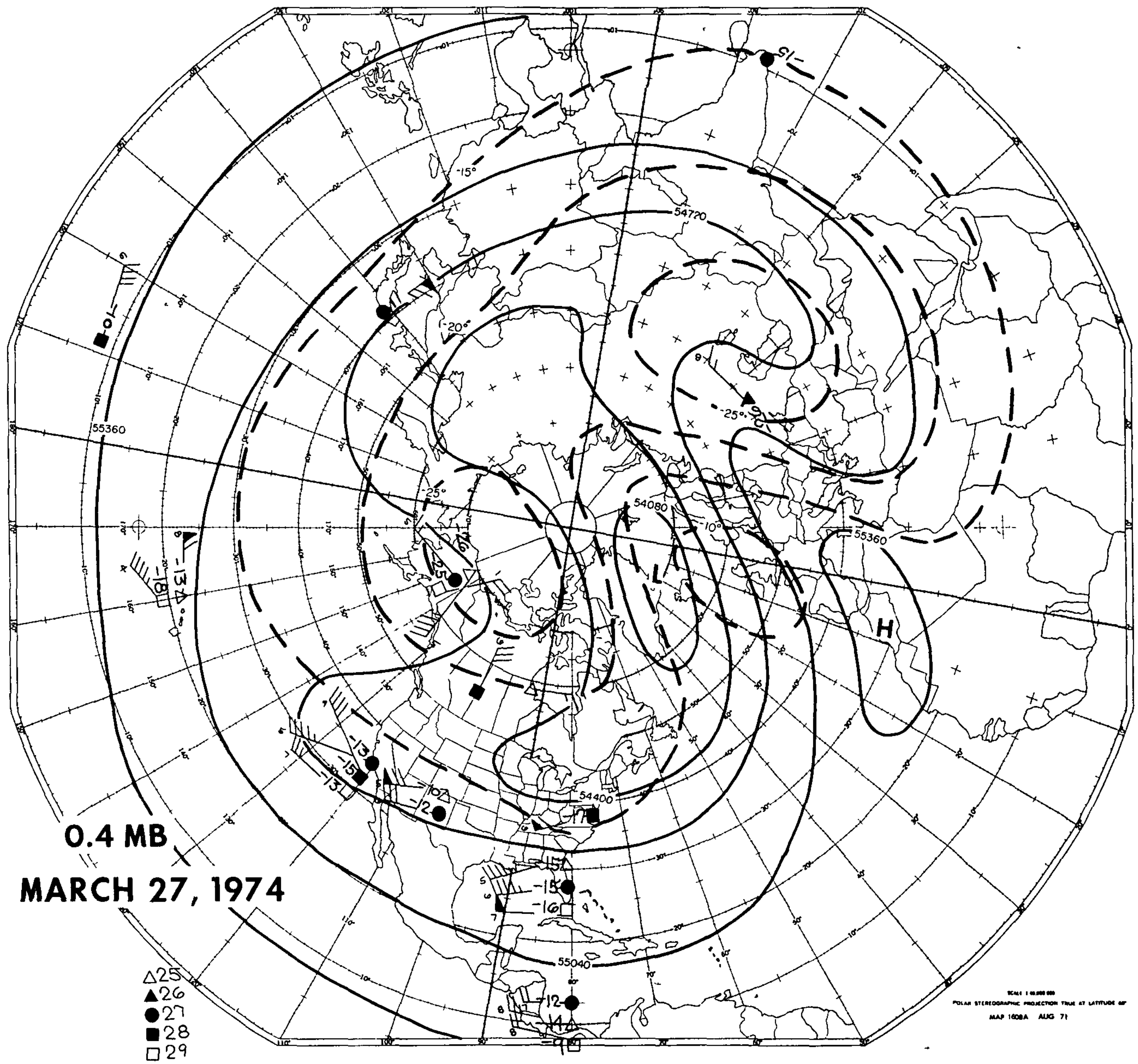

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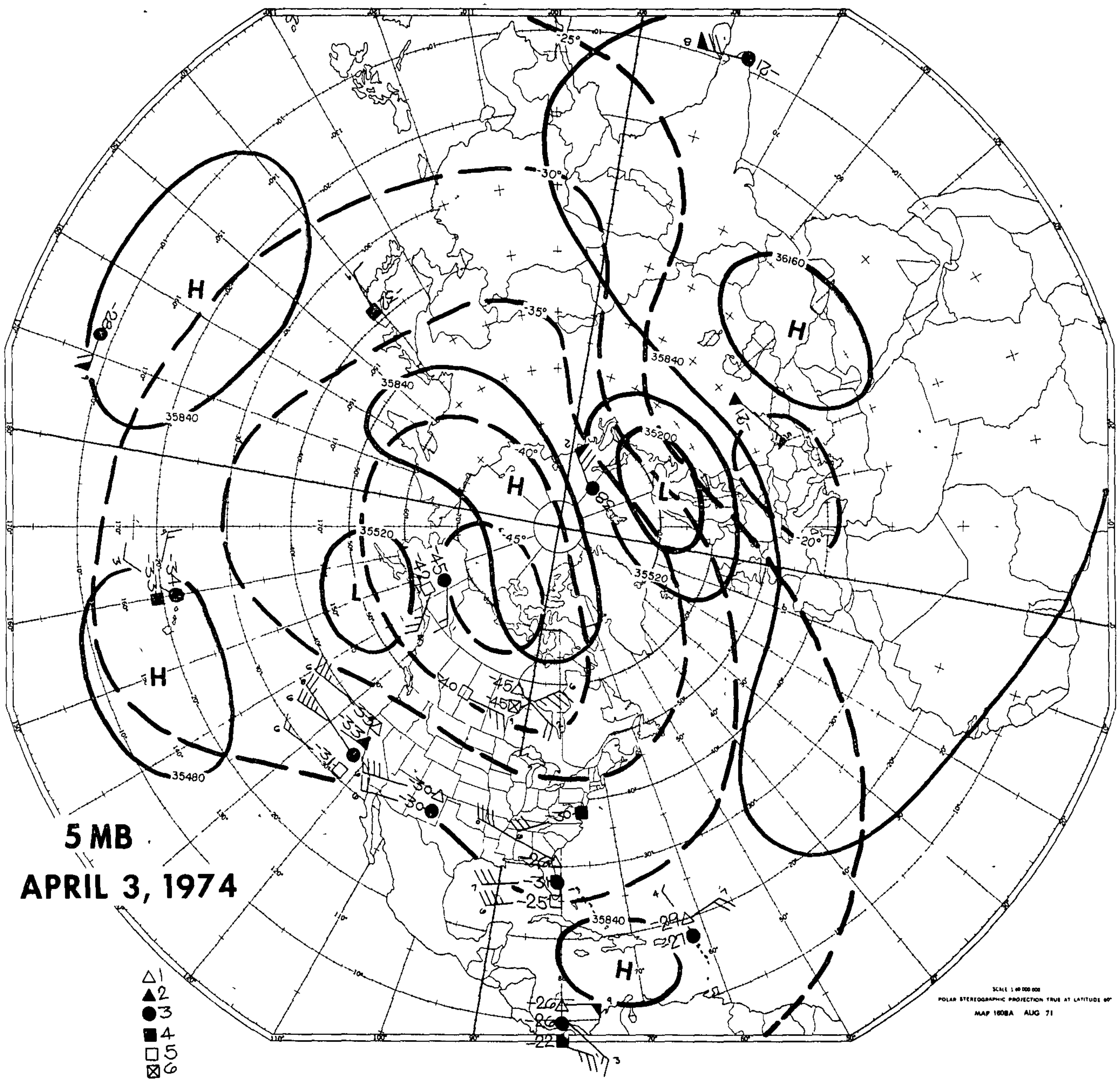
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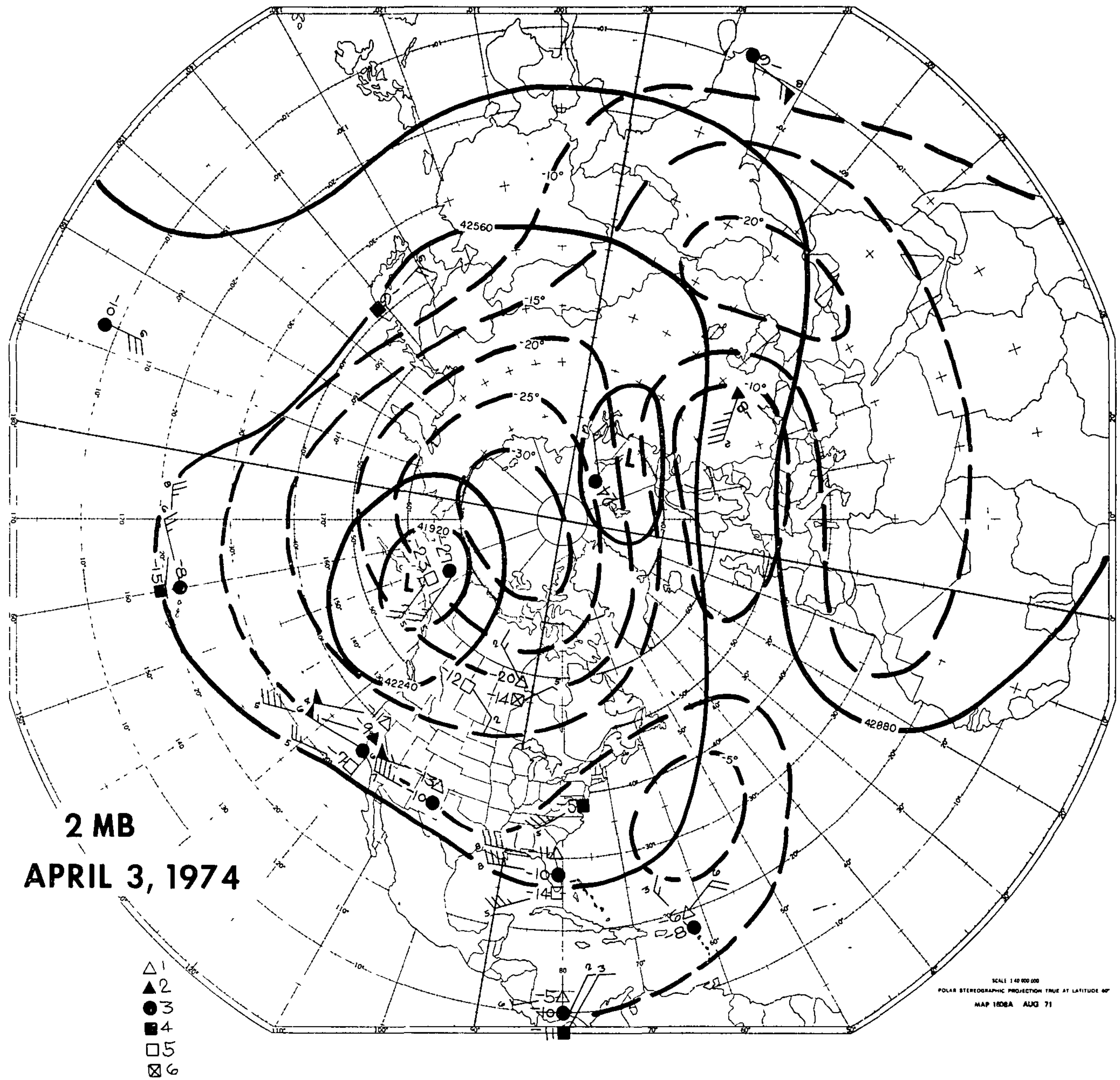
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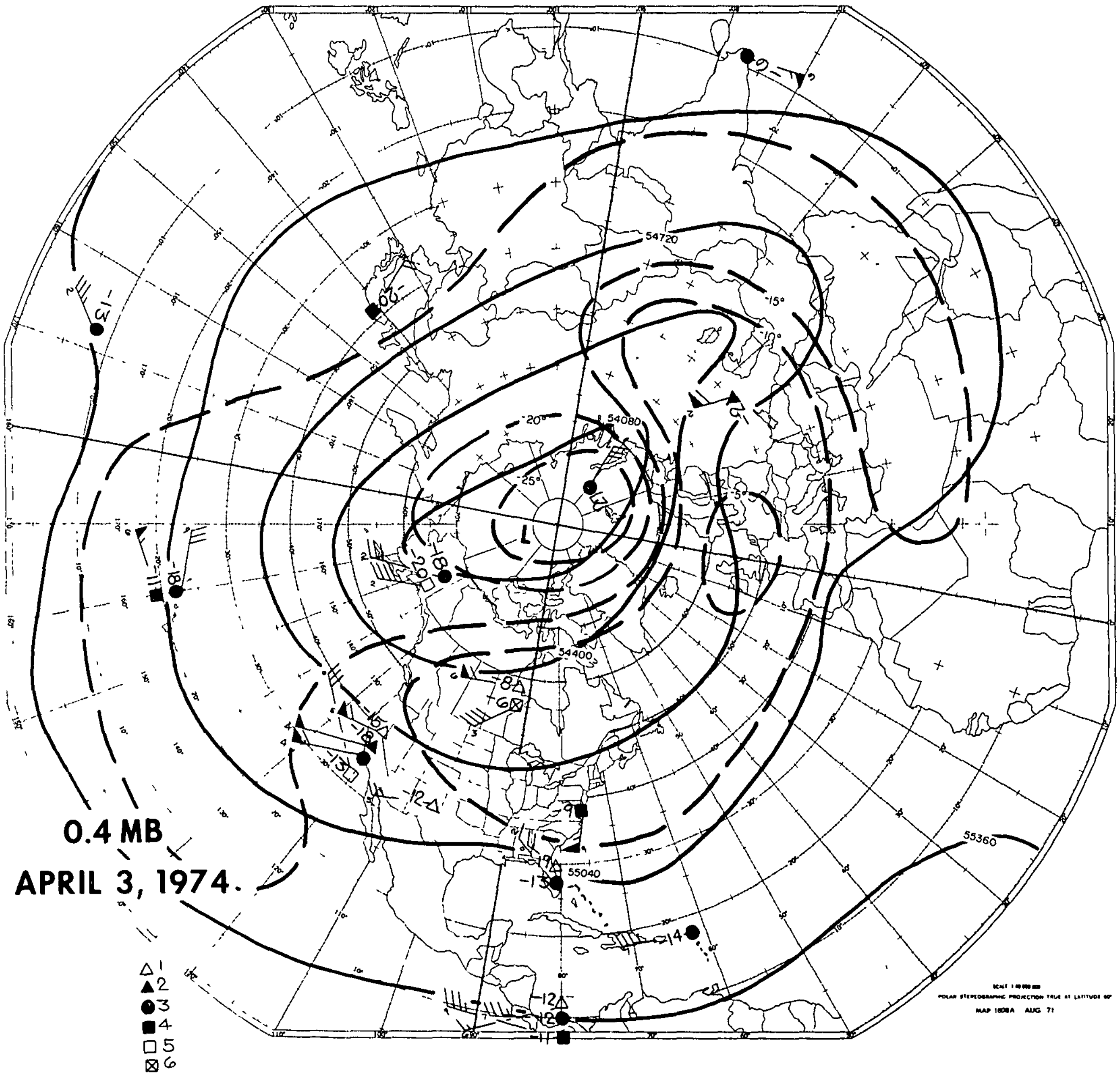
MAP 1608A AUG 71



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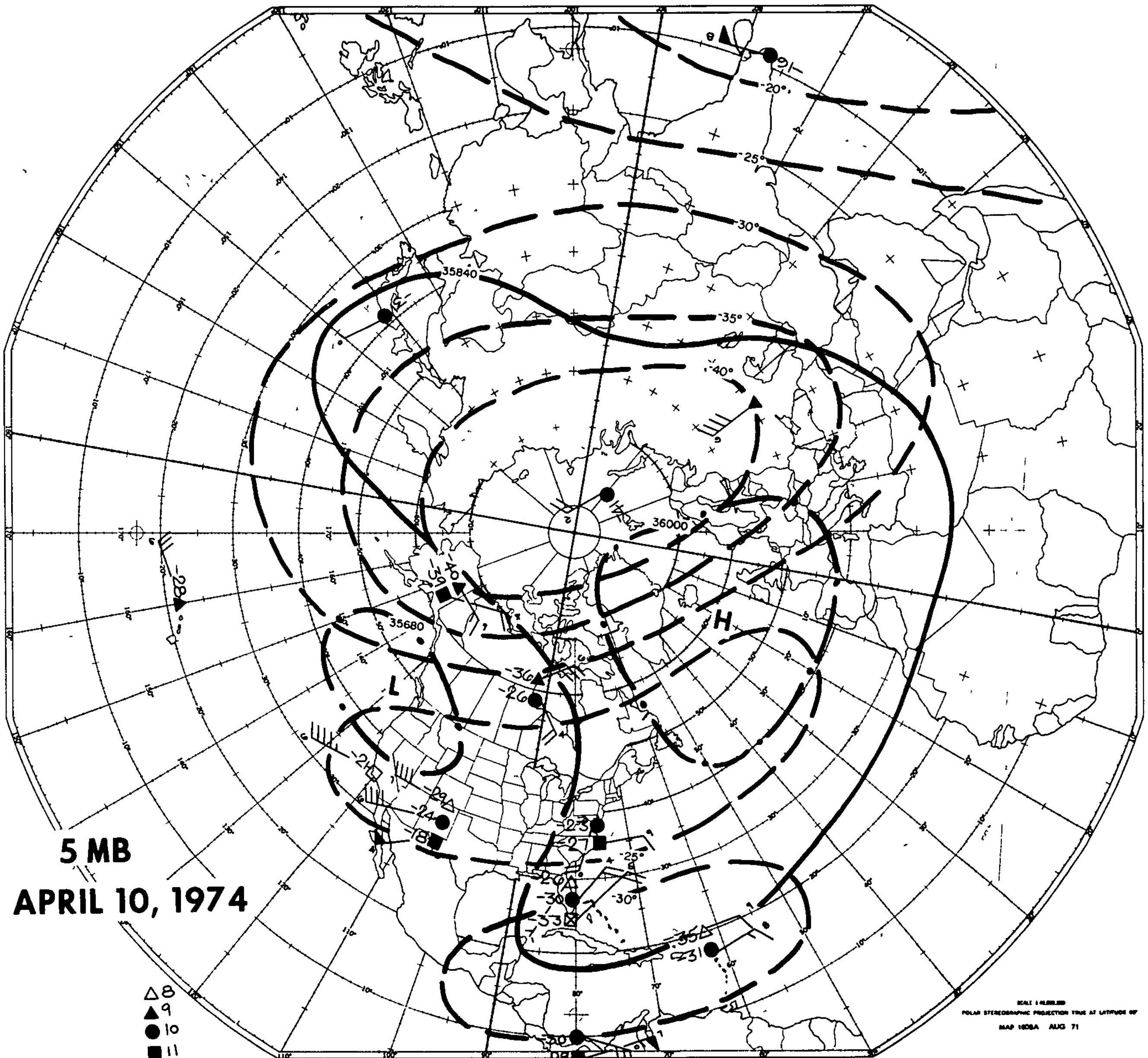

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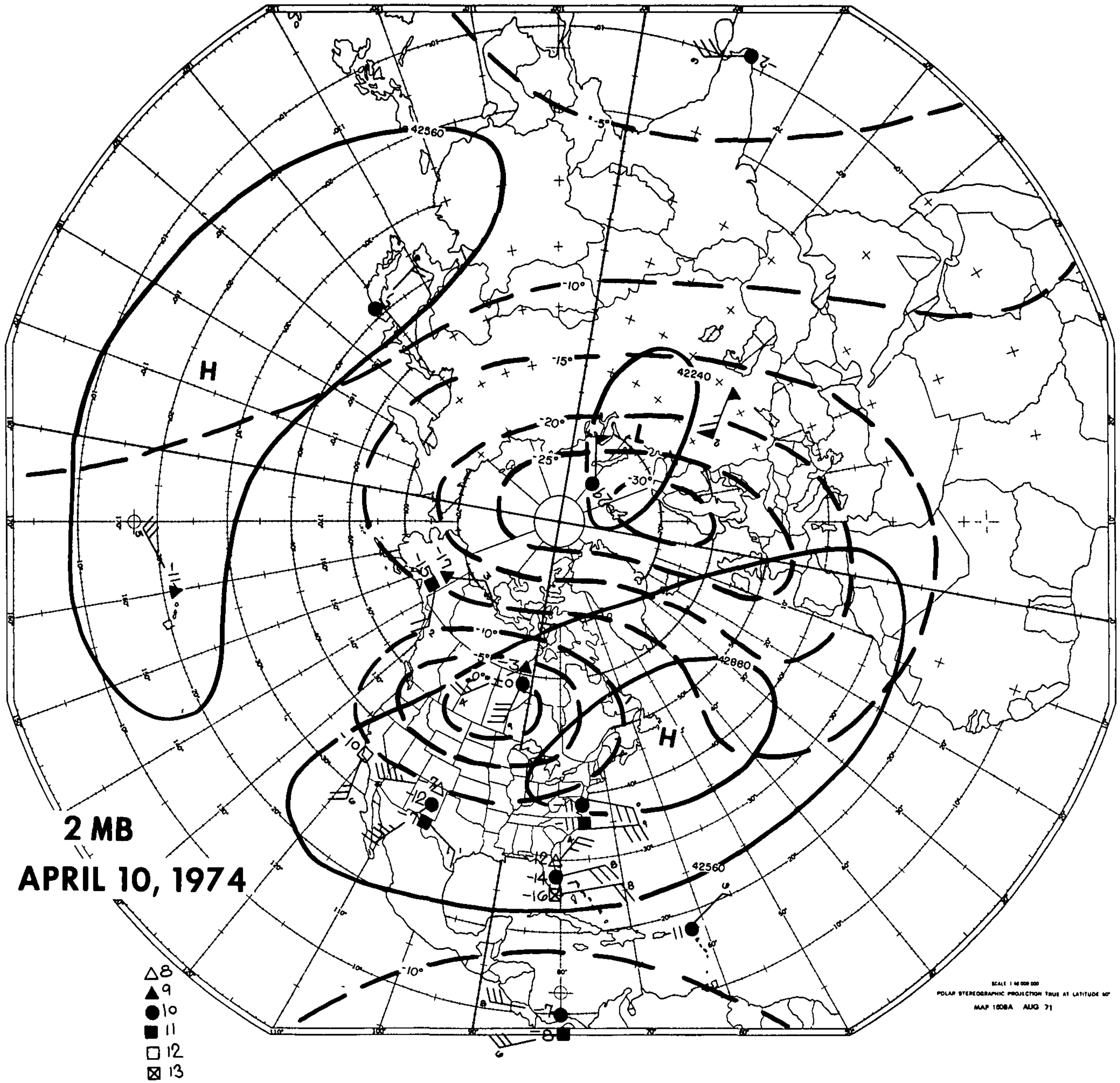
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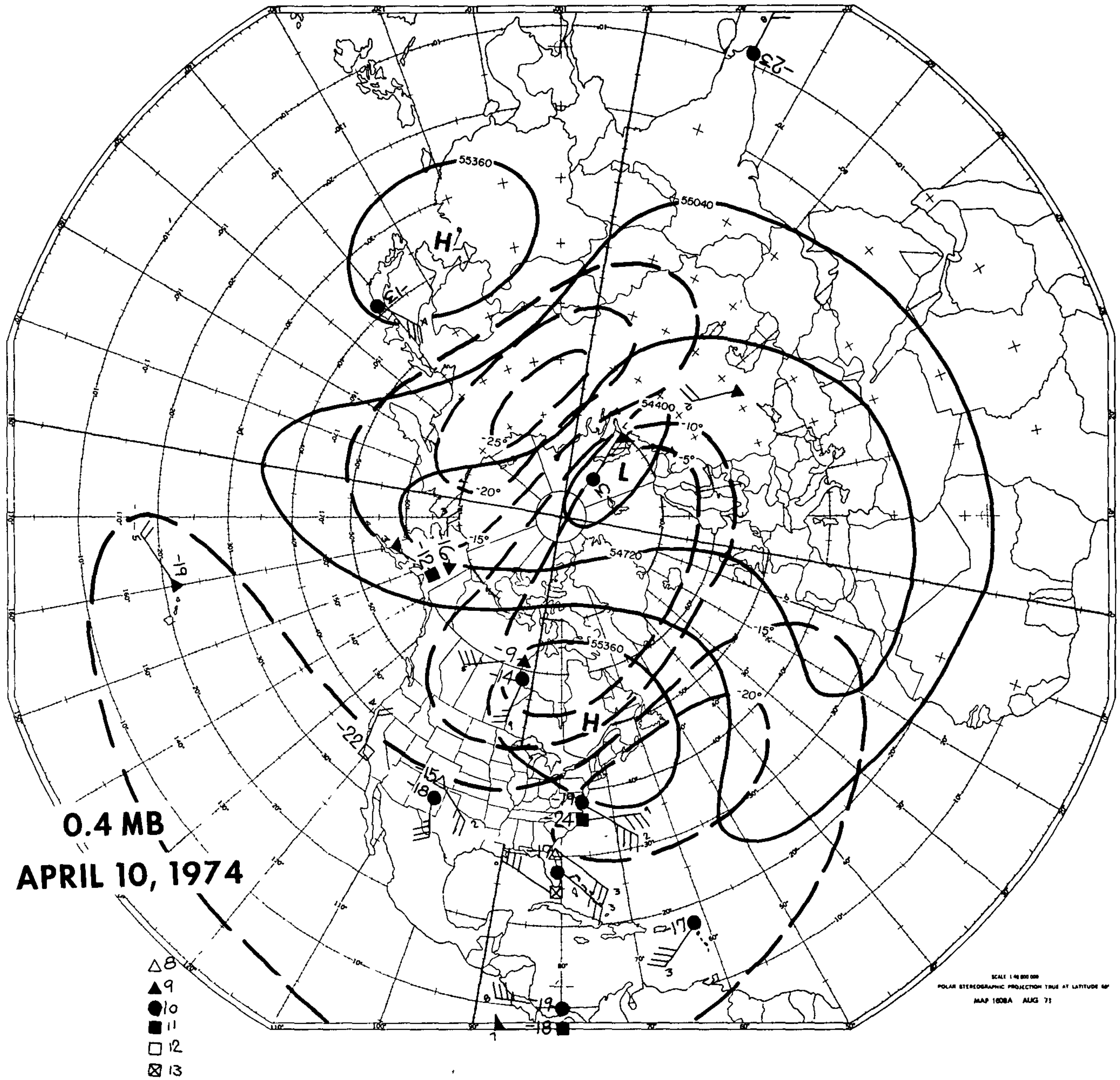
POLAR STEREOGRAPHIC PROJECTION TRUE AT LATITUDE 60°
MAP 1608A AUG 71



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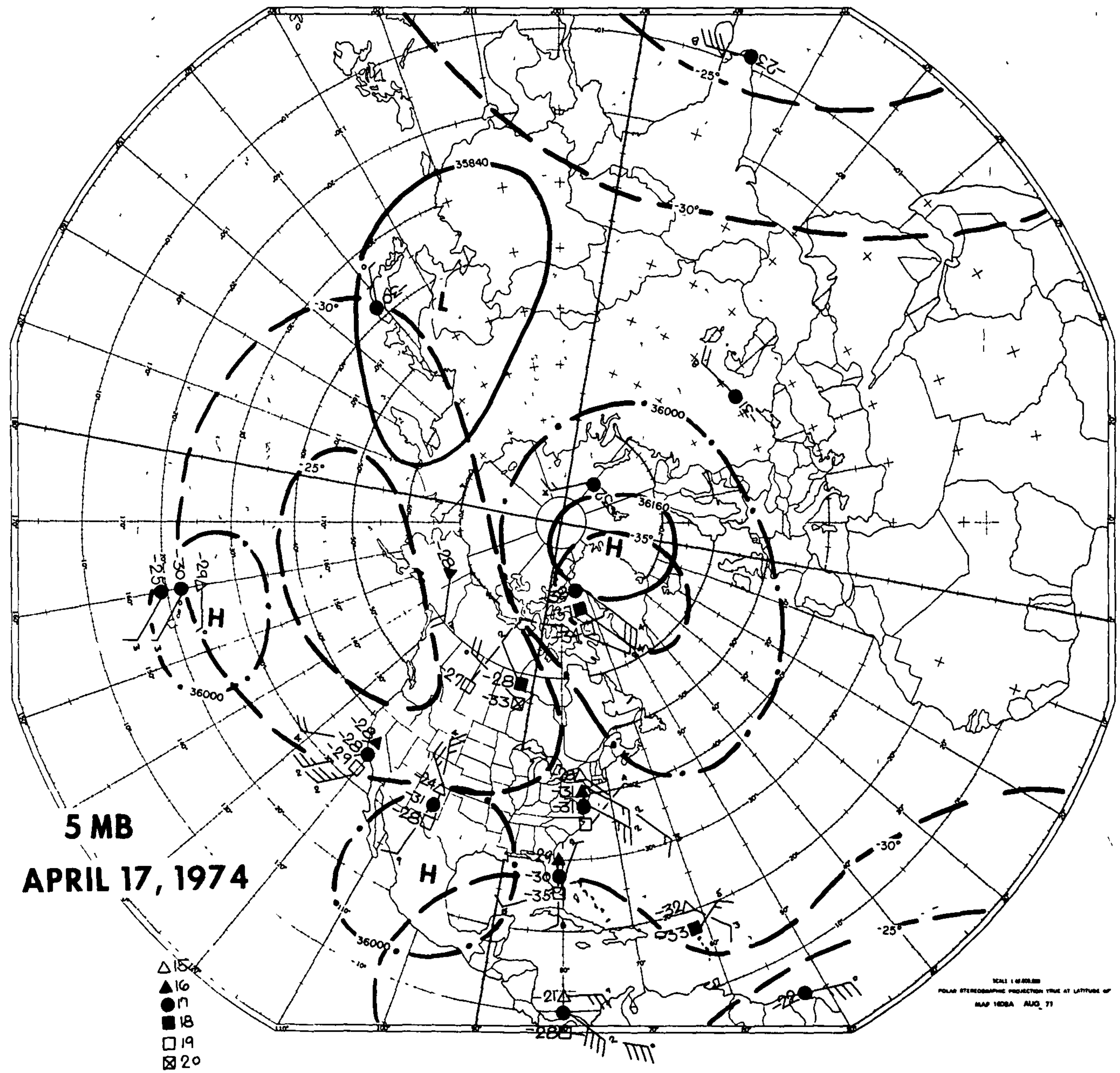

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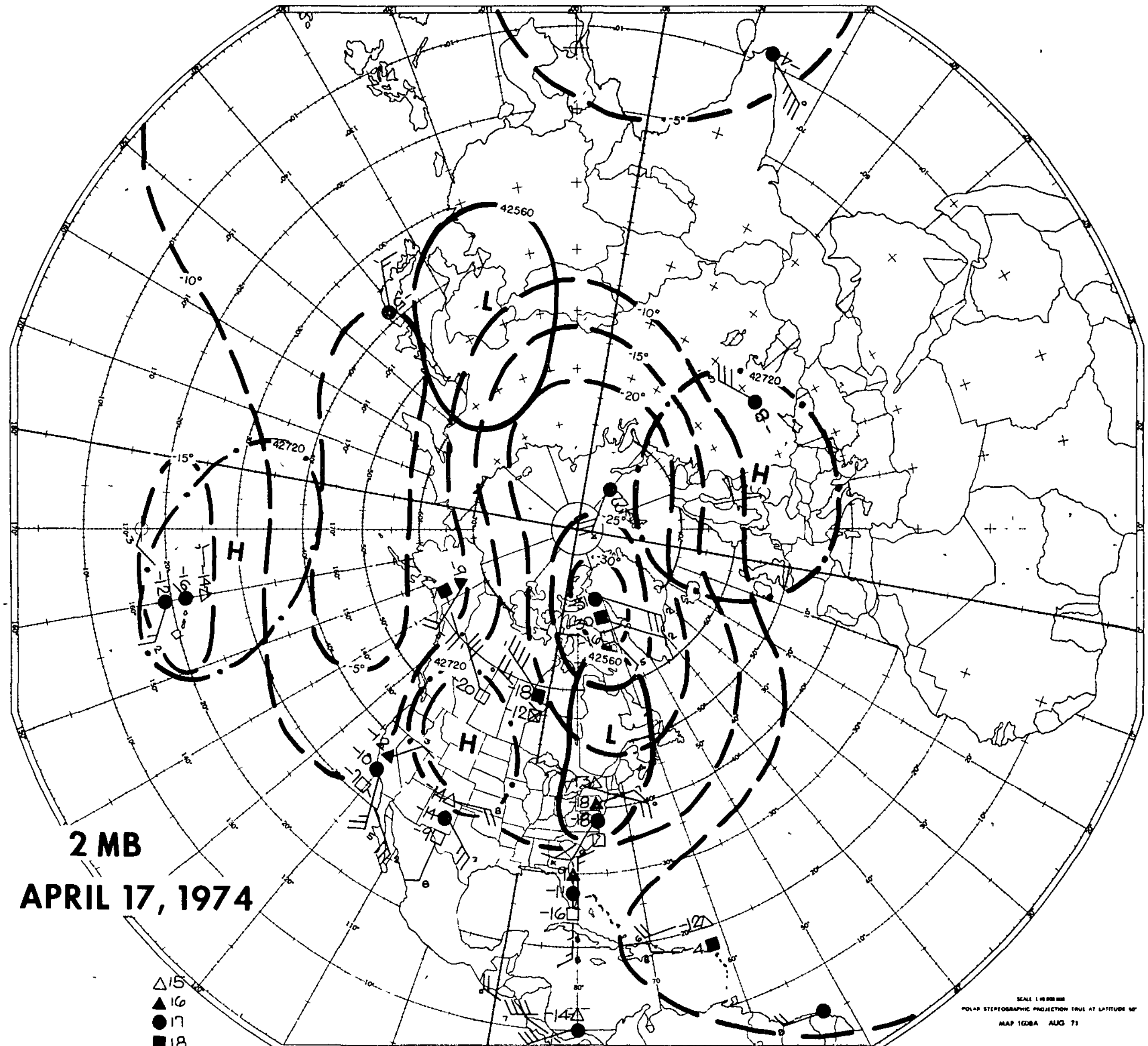

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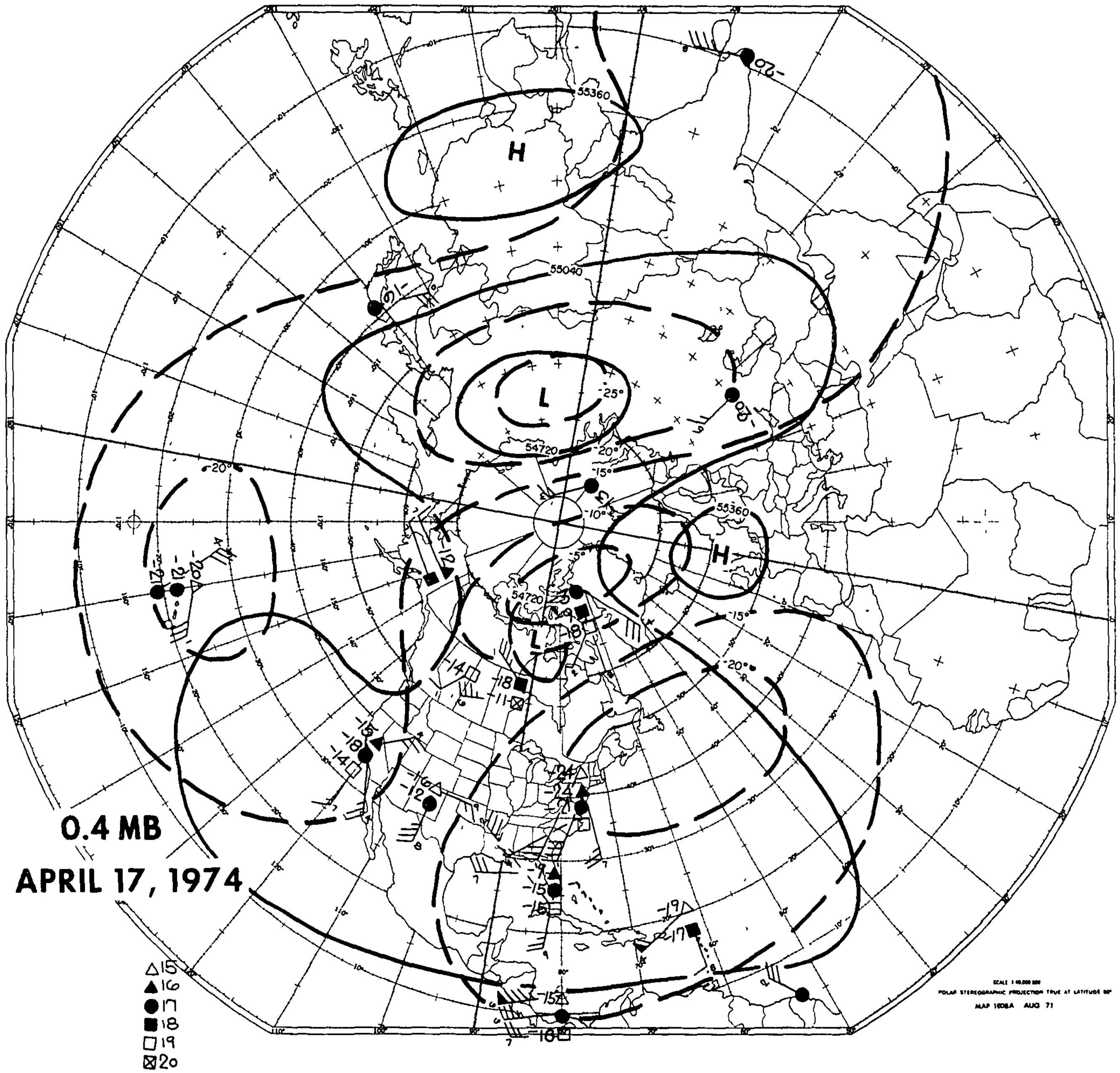

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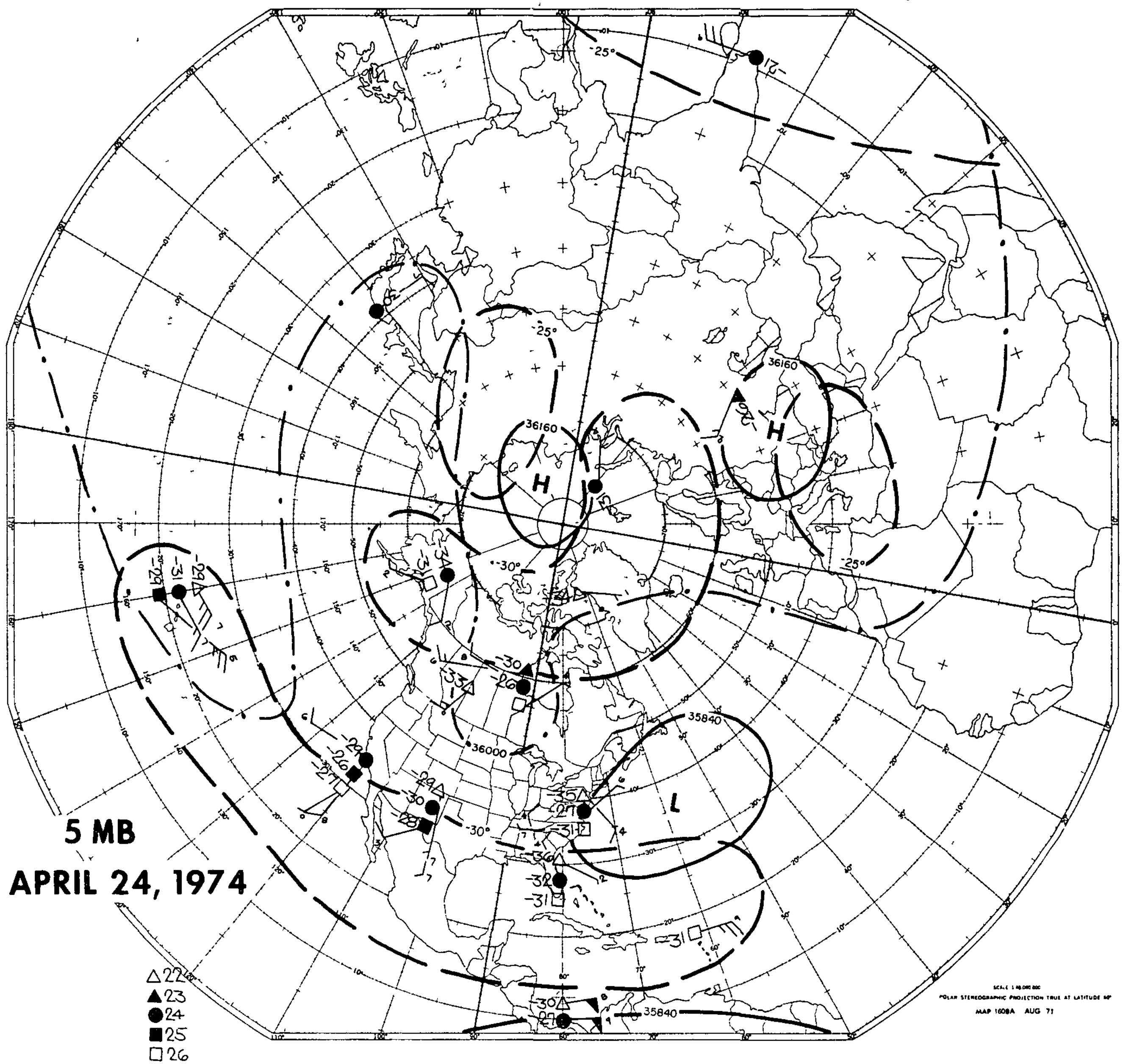

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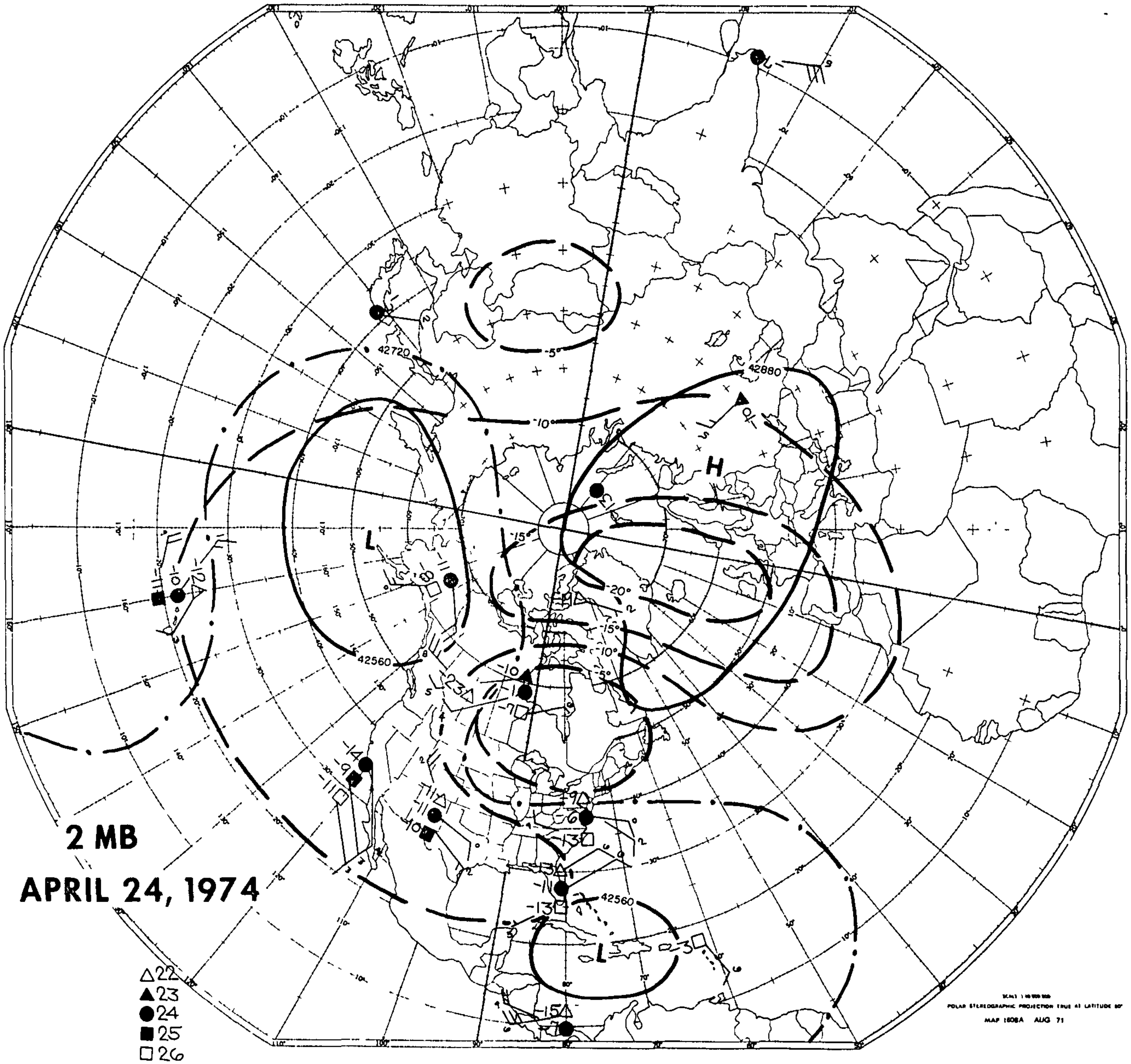
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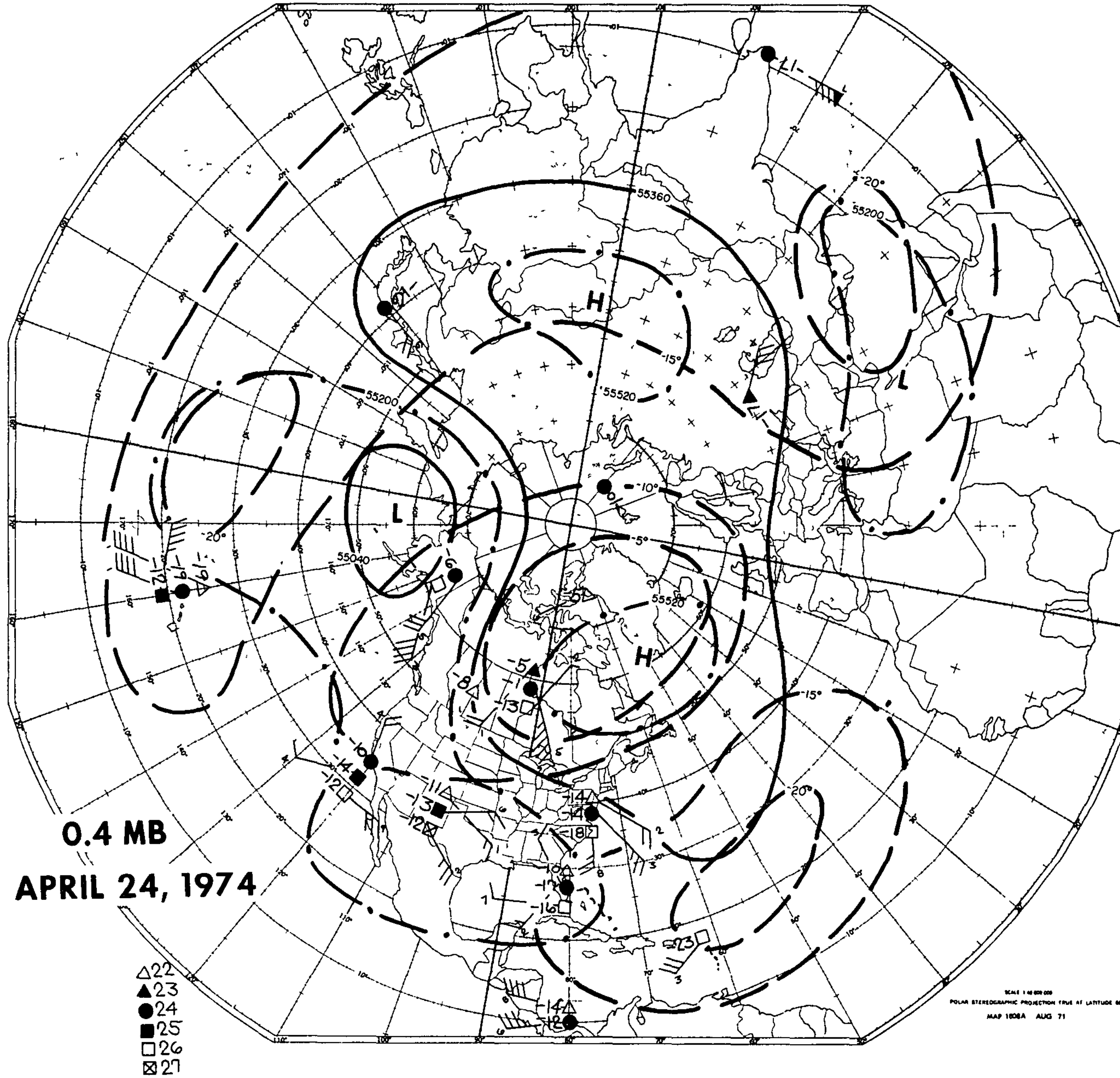
POLAR STEREOGRAPHIC PROJECTION TRUE AT LATITUDE 60°
MAP 1608A AUG 71



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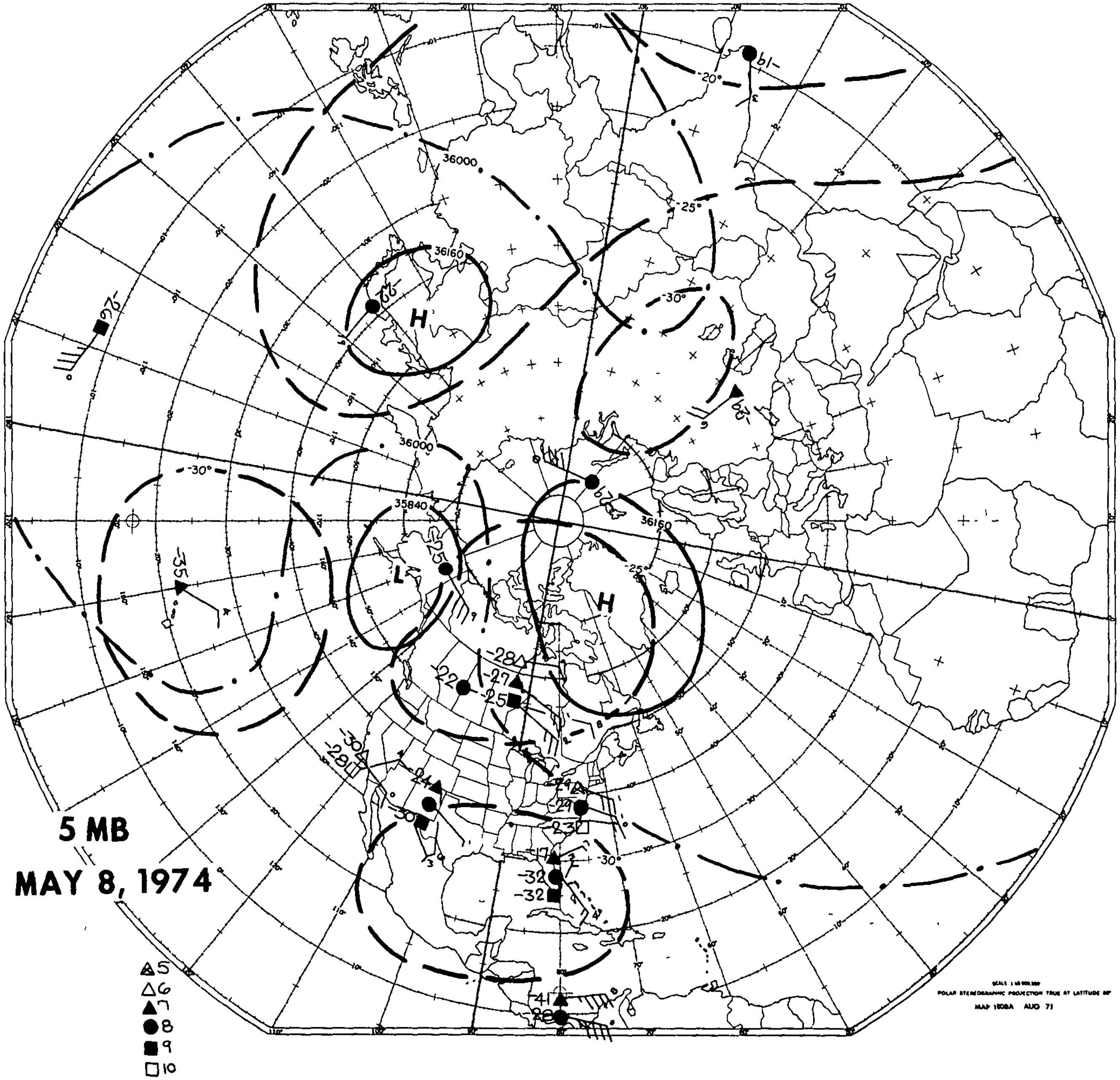

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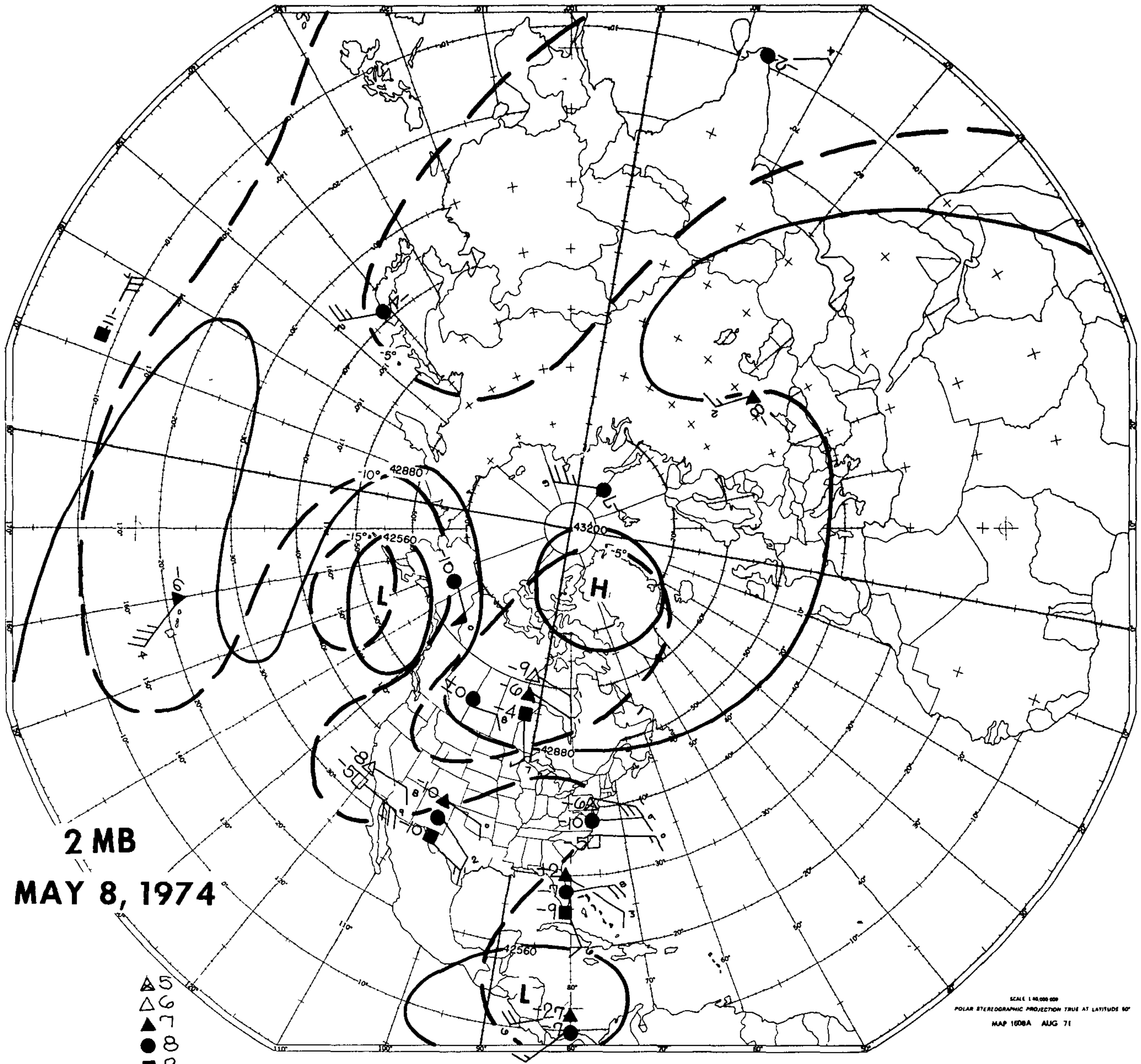

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MAY 8, 1974

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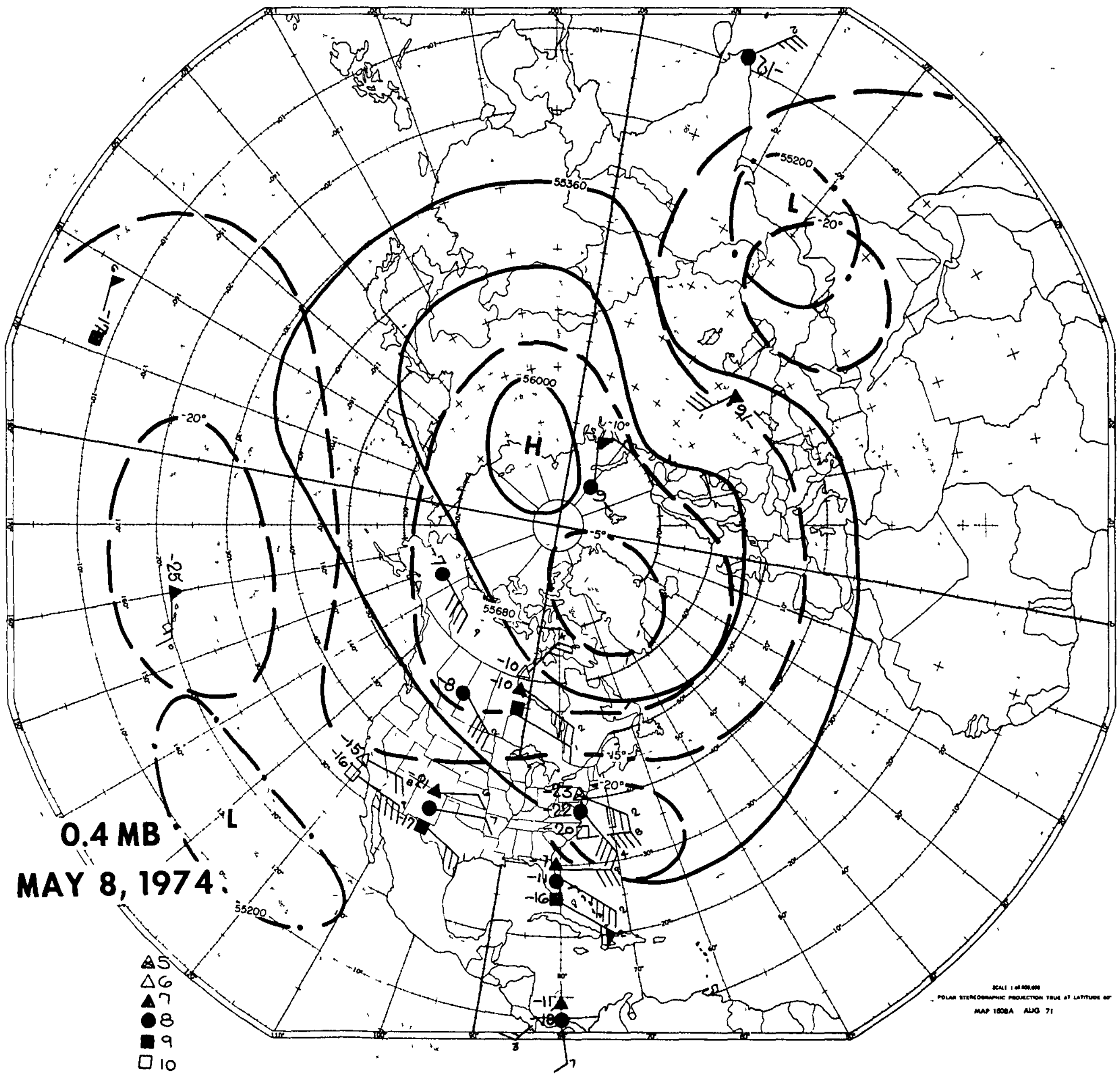

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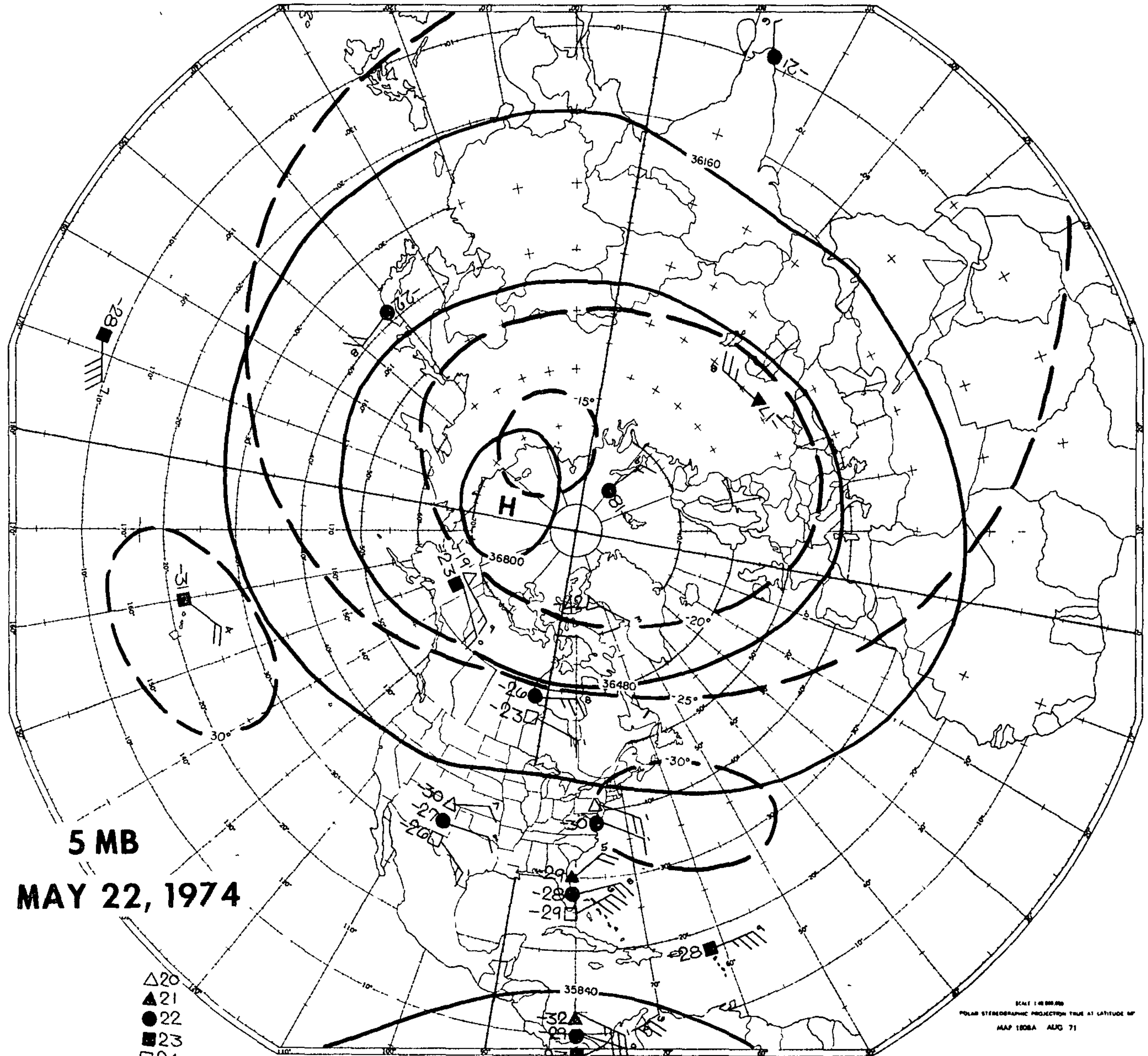

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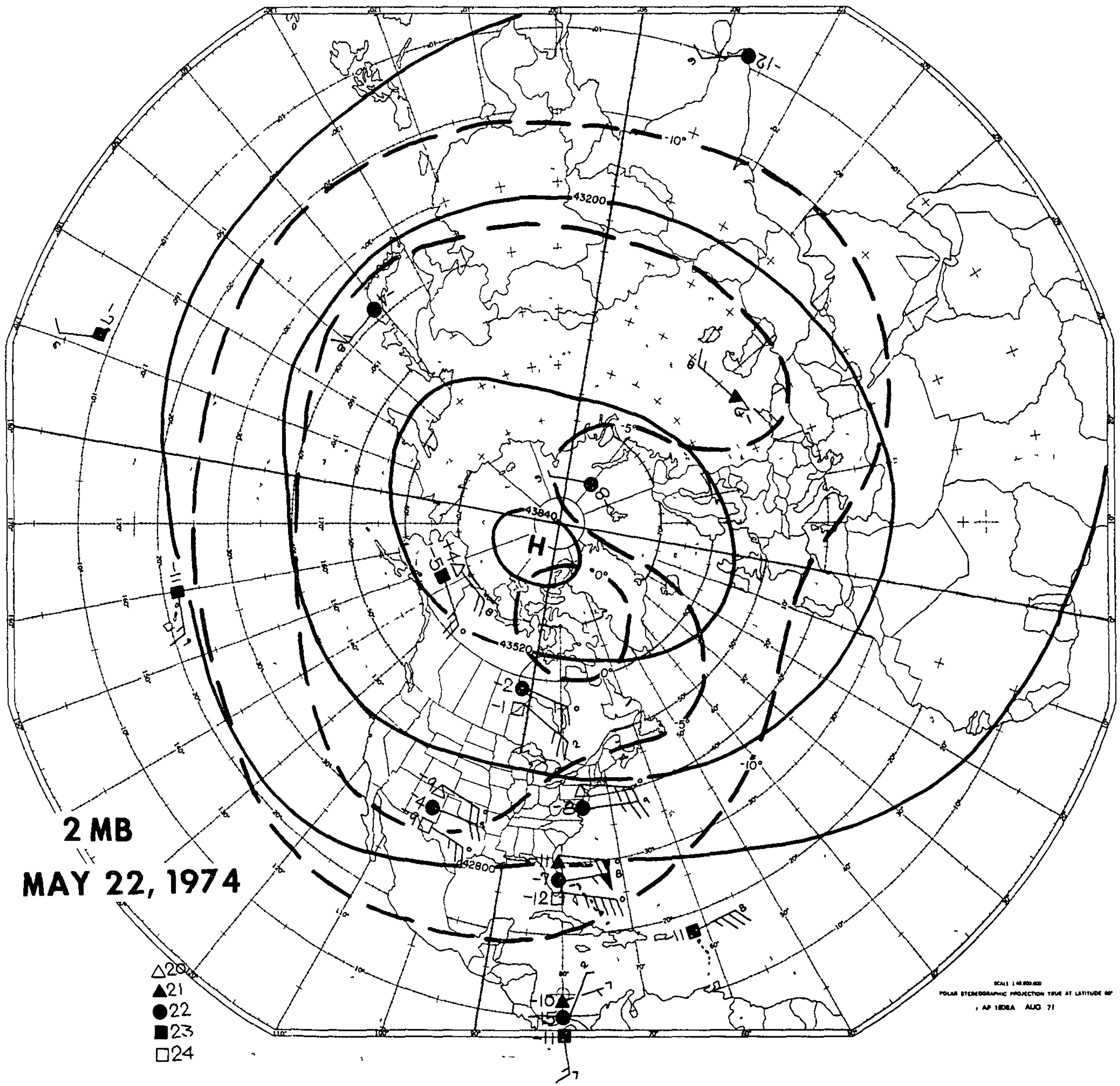

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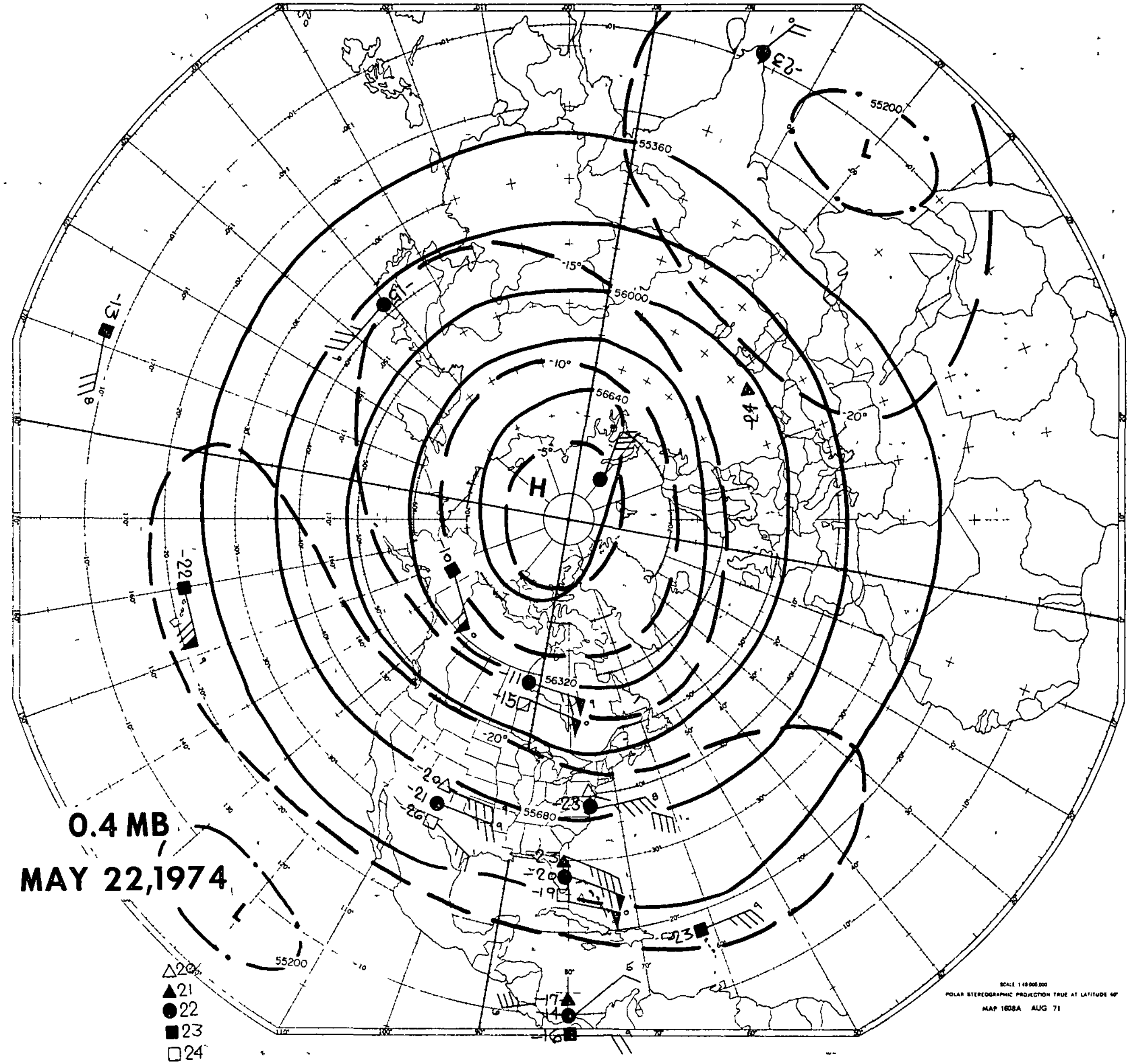
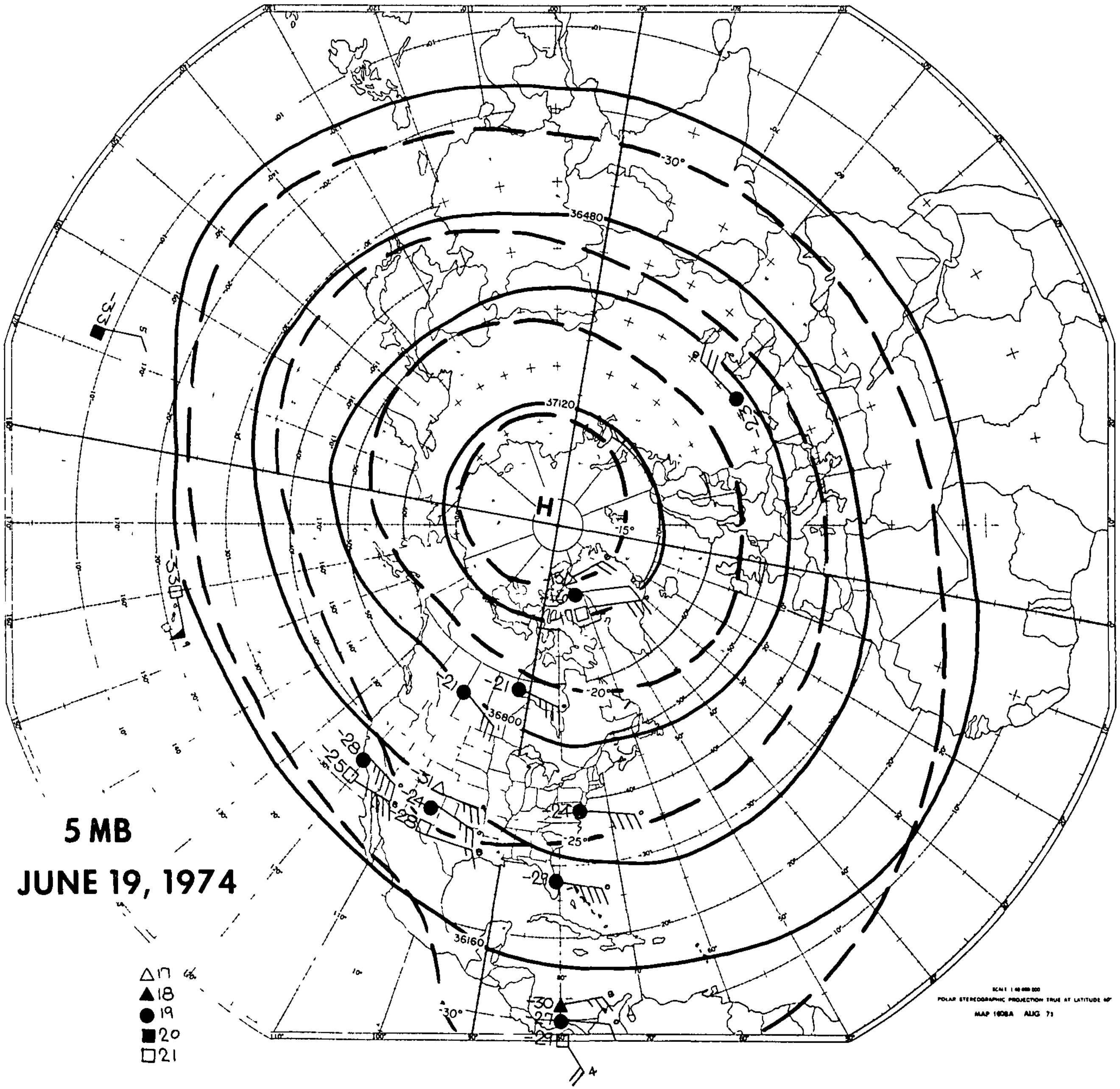
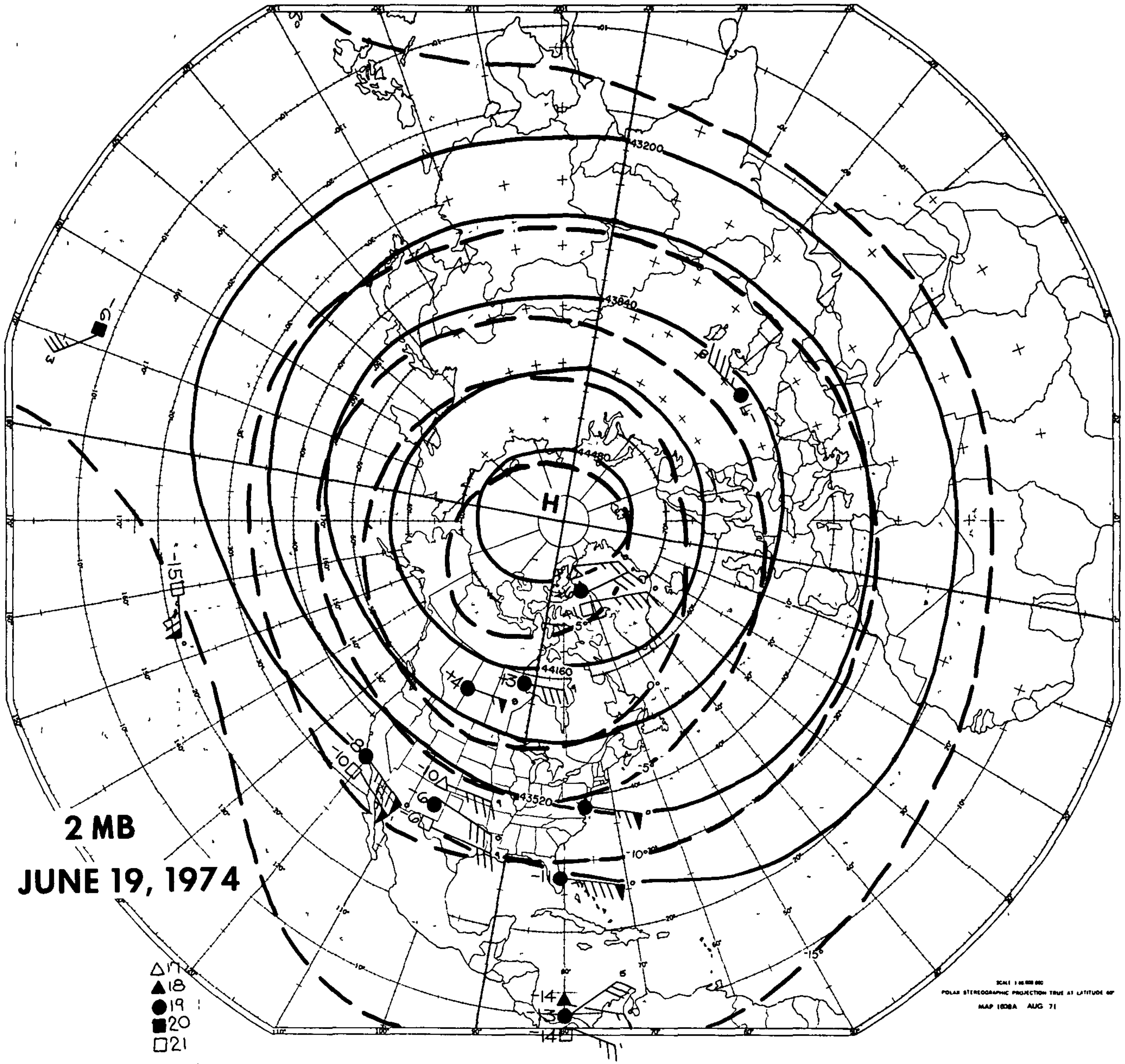

0.4 MB
MAY 22,1974
H
L
L
55200
55360
56000
56640
56320
55680
55200
-15°
-10°
-5°
-20°
-20°
△20
▲21
●22
■23
□24


5 MB
JUNE 19, 1974
H
37120
36800
36480
36160
-15°
-20°
-25°
-30°
△17
▲18
●19
■20
□21
SCALE 1:40 000 000
POLAR STEREOGRAPHIC PROJECTION TRUE AT LATITUDE 60°
MAP 1608A AUG 71



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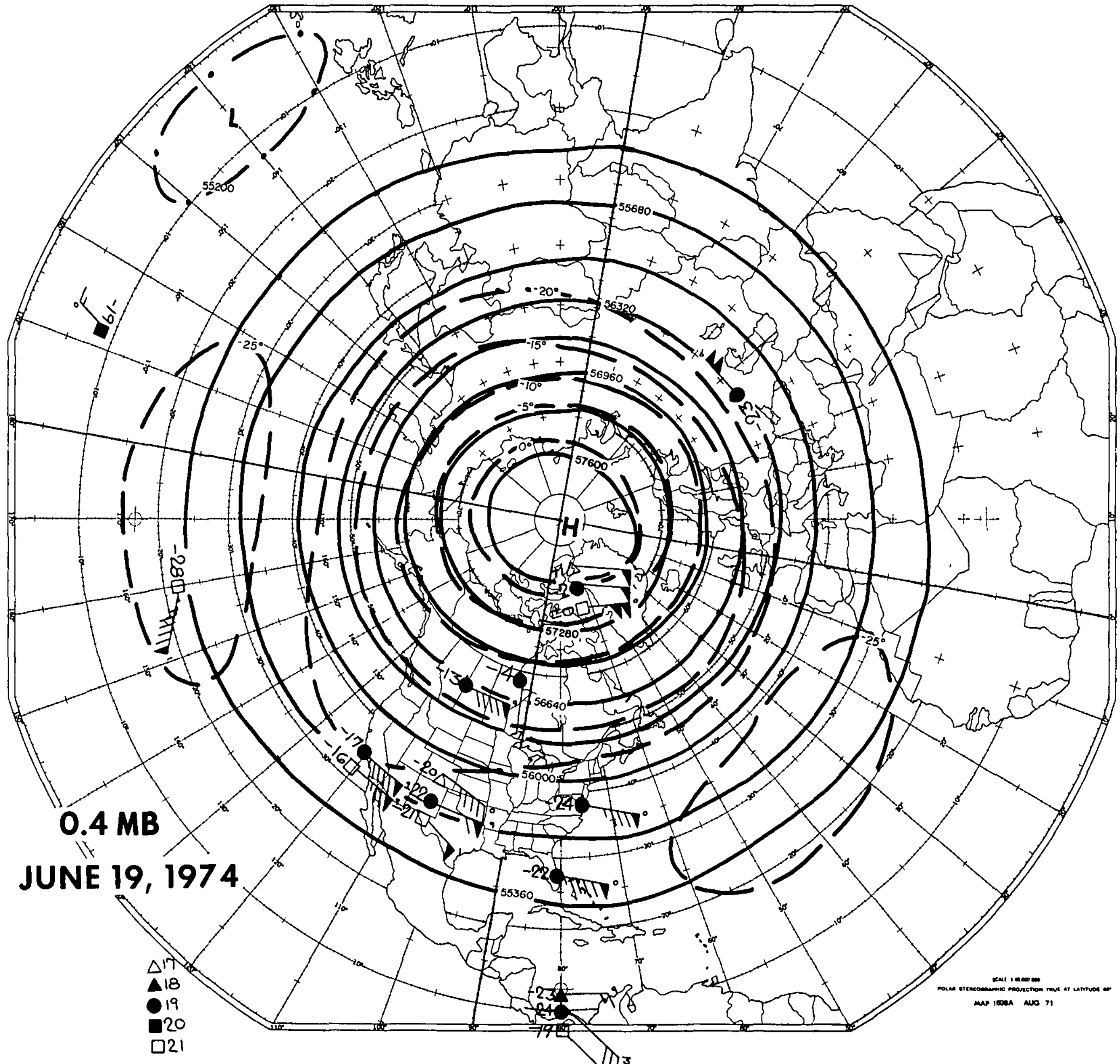
JUNE 19, 1974



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JUNE 19, 1974

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